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Vol. VI

Chicago

APRIL, 1910

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No. 4

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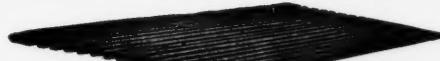
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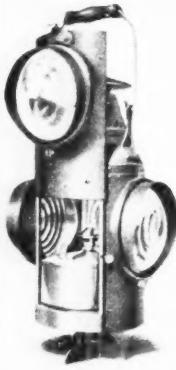
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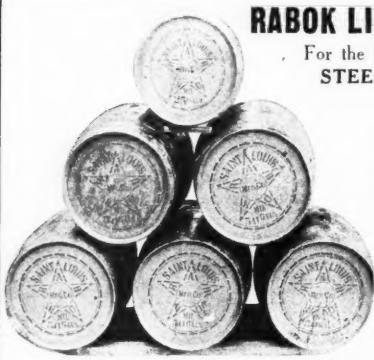
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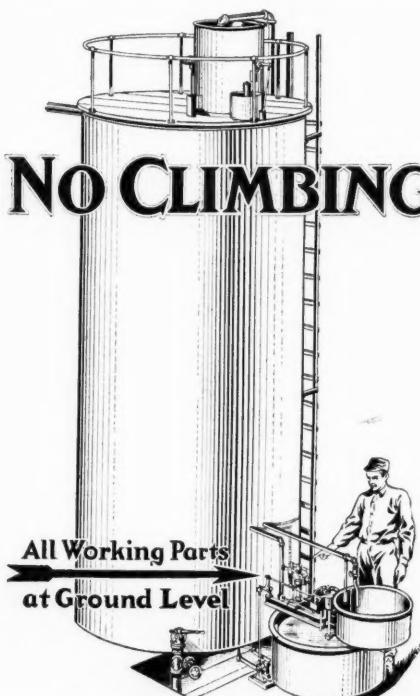
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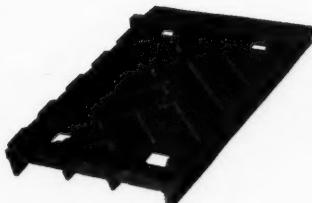
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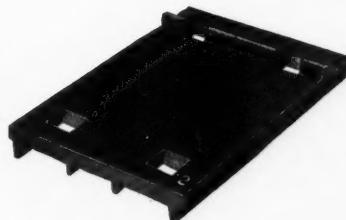
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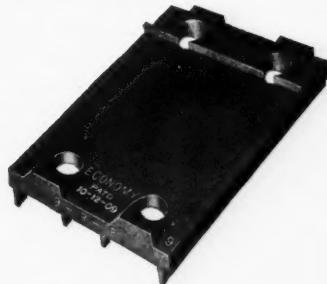
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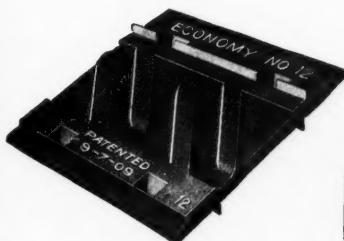
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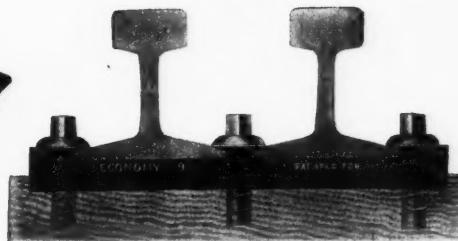
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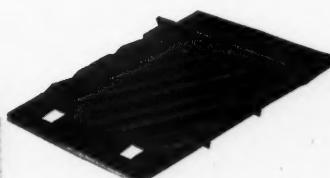
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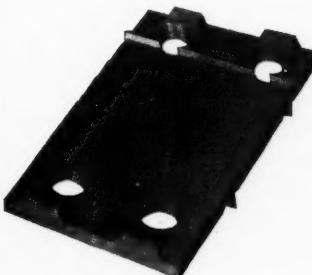
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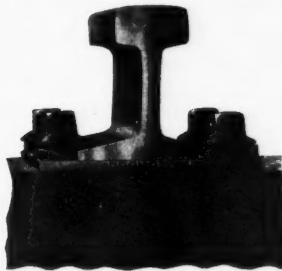
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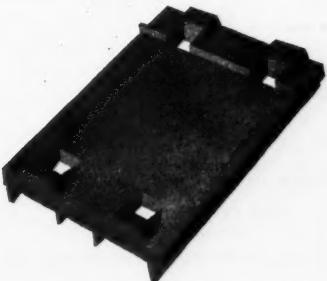
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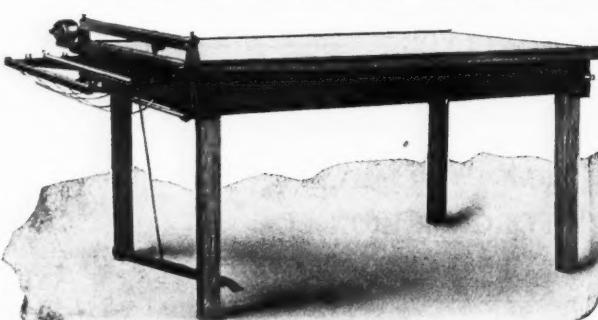
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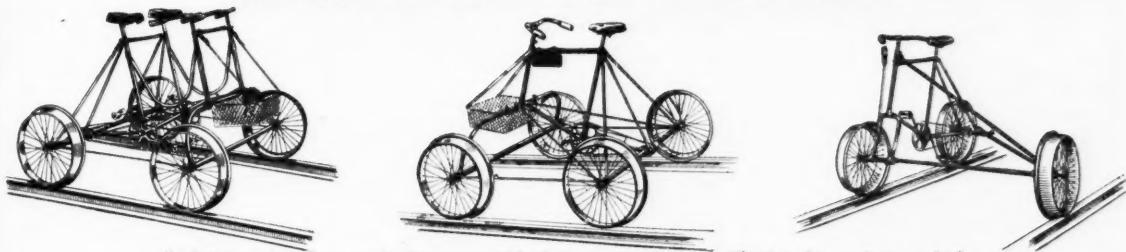
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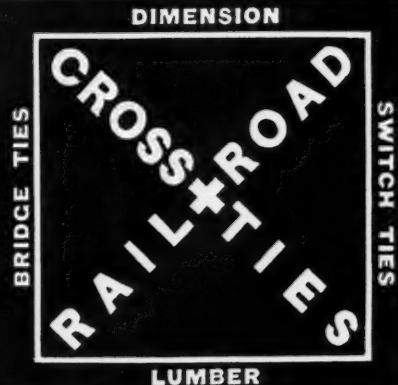
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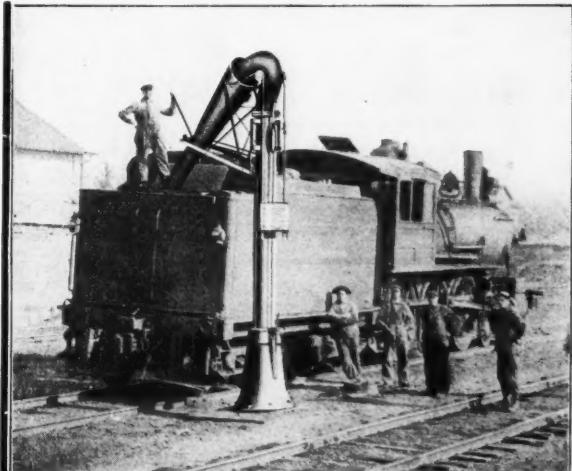
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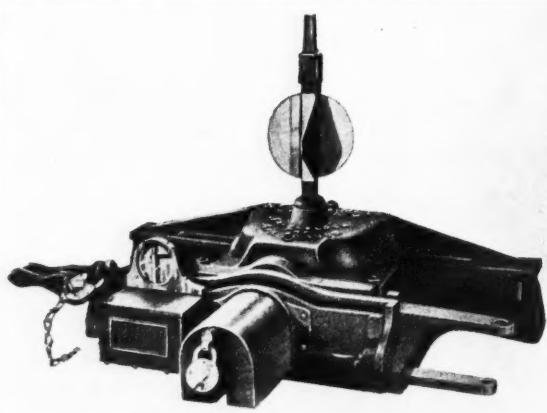
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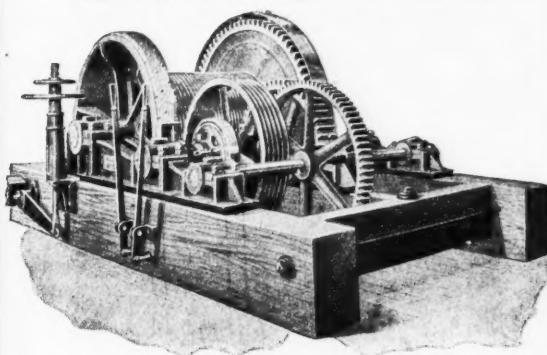
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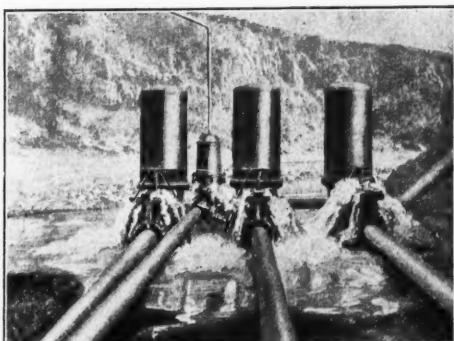
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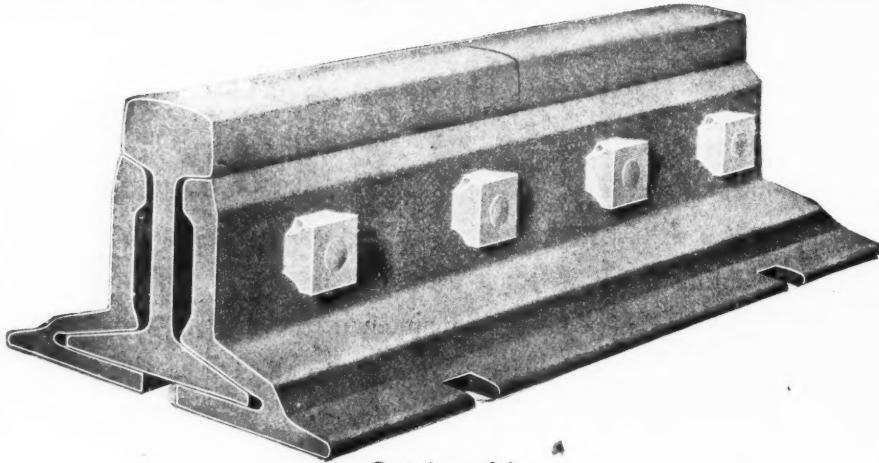
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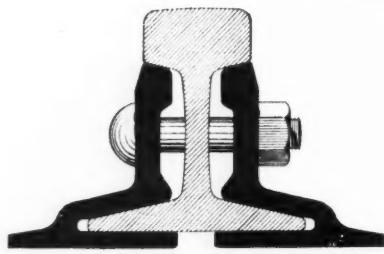
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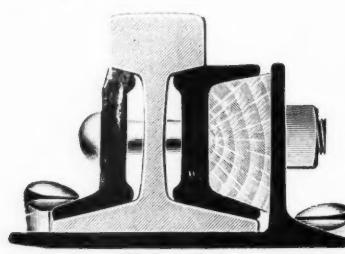
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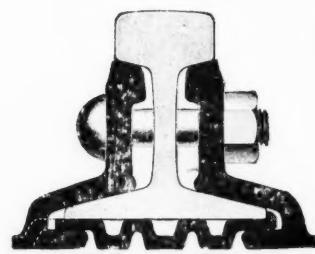
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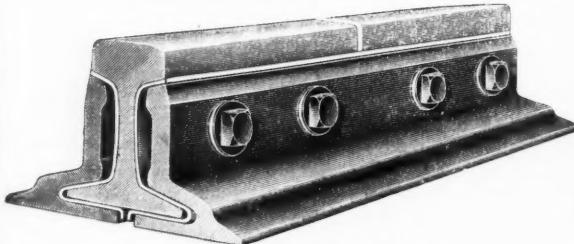
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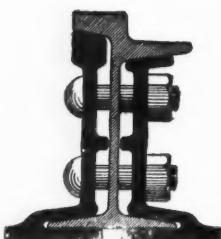
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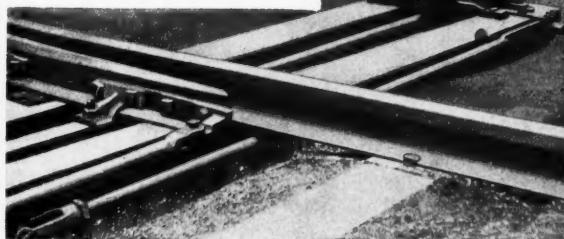
One movement of the lever first closes the switch, then interlocks the points, then clears the signals. Unless the point comes up to the rail and is interlocked the lever stops near the vertical and the distant signal remains at danger. The reverse movement of the lever first sets the signals to danger, then withdraws the interlock, and then opens the switch. If the switch is left open the distant signal remains at danger.

Cars can be switched on the main line and the distant signal held at danger for protection by moving the lever from one side to the vertical.

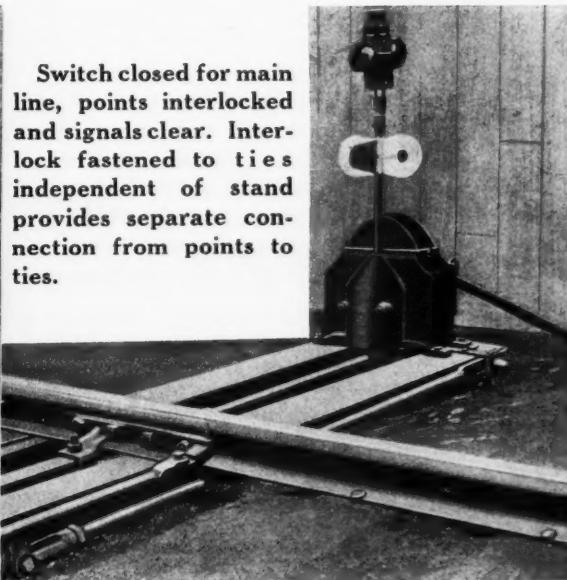
The interlock is fastened to the ties independent of the stand and provides a separate connection from the points to the ties. If the stand is destroyed the interlock will hold the points. By placing the front rod below the top of ties the interlock will hold the main line point if the switch connections are dragged out.

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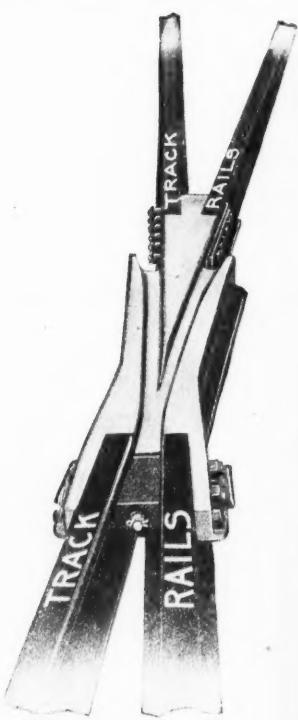
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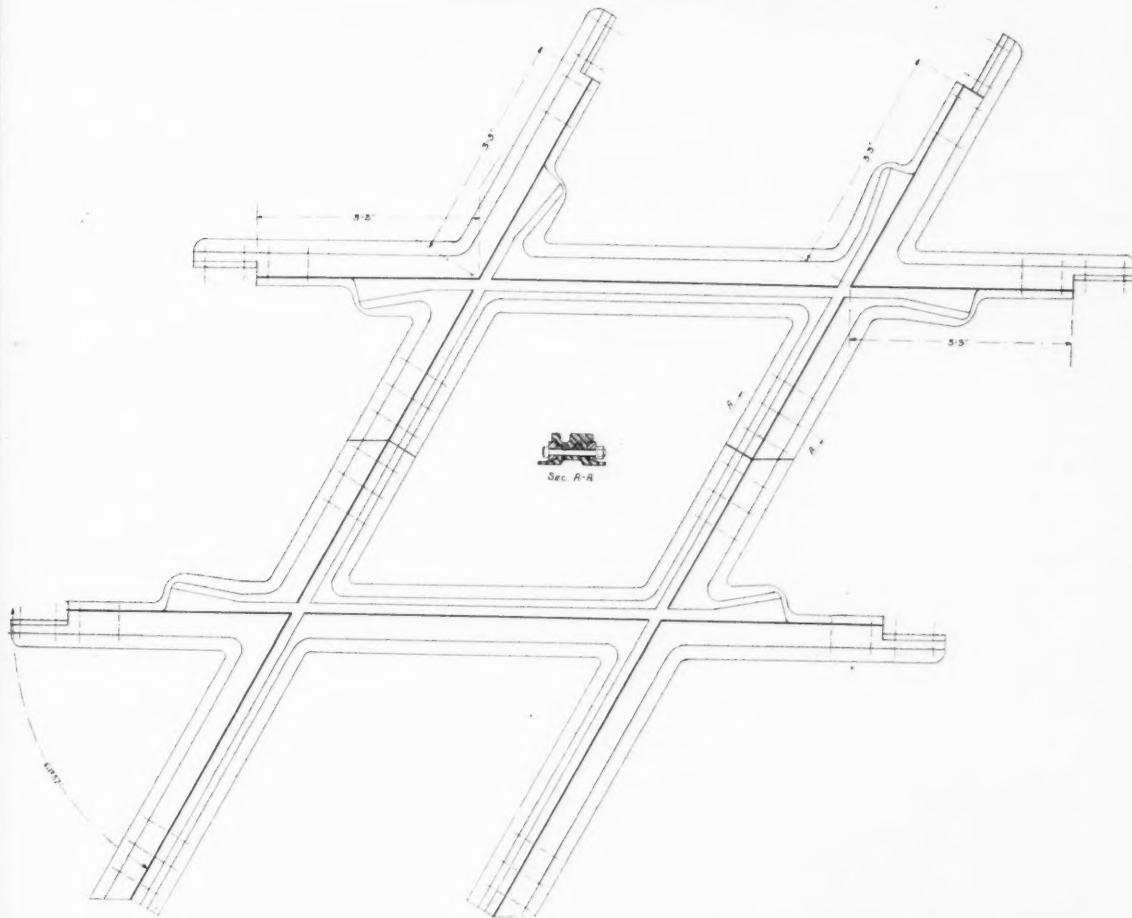
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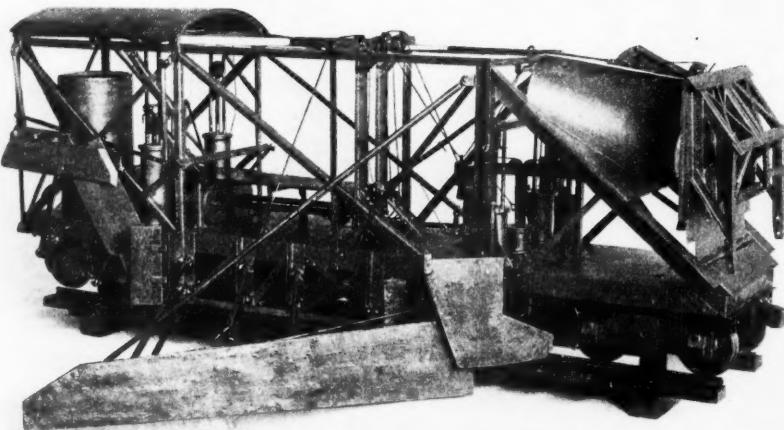
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THE MANN No. 3 SPREADER, BANK SHAPER, FOLDING SNOW PLOW, BANK BUILDER

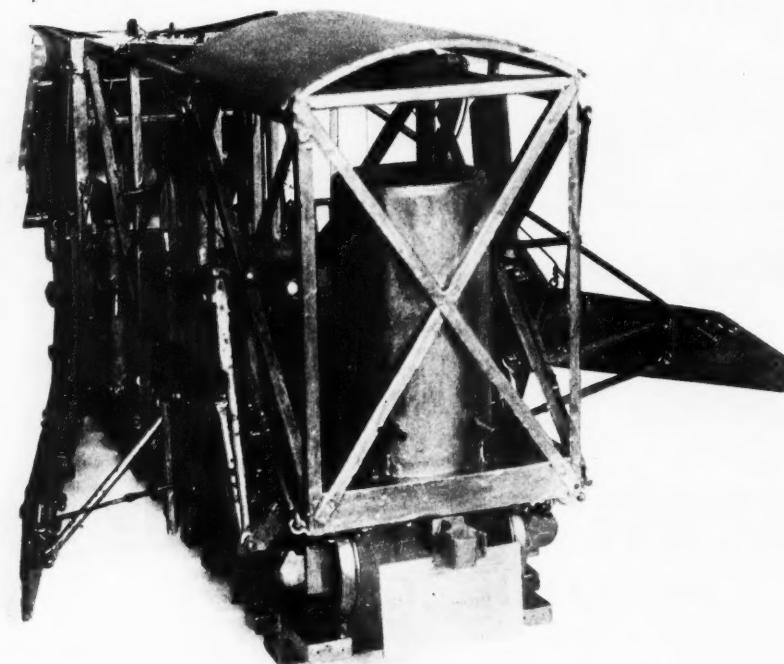
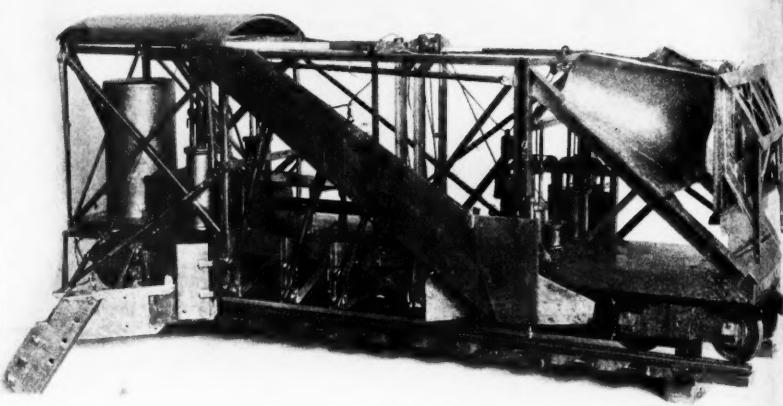


Bank Shaper down to working position. Any desired cross section can be formed from end of tie out 5 feet and down side of bank any distance not exceeding 4 feet at any angle, forming a true top surface shoulder and side surface. Good for cutting weeds, filling in gullies, shaping banks, etc. Operated by one air cock, can be put in or taken out of service in ten seconds.

Costs less than \$1.90 per mile to finish up track on both sides with this shaper.

Main wing down to spread level at 24 inches below top of rail, adjustable to spread level at any desired height up to 12 inches above top of rail; also to slope up or down out from end of tie any distance not exceeding 19 feet.

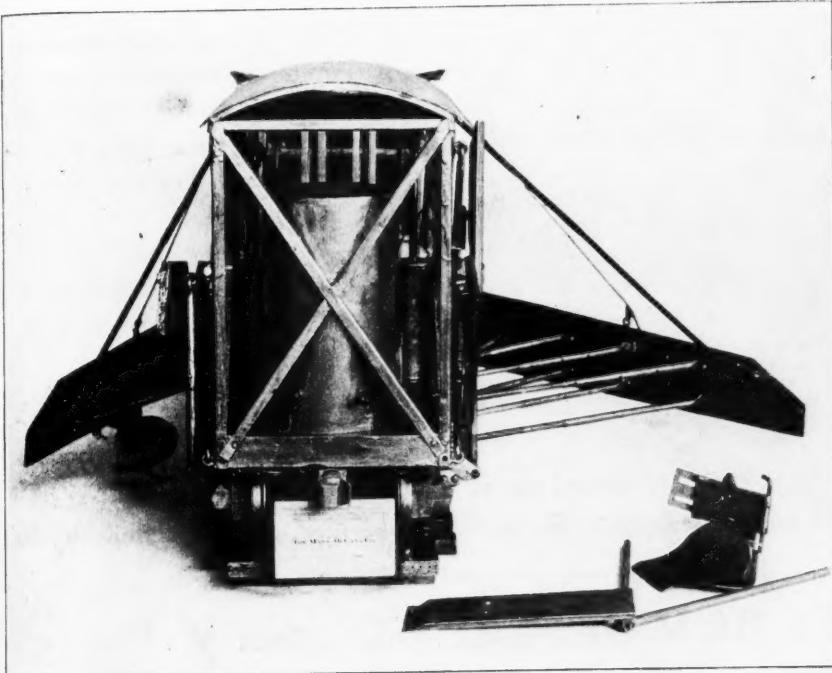
Operated from platform directly in front of air reservoir by opening two air cocks both wings locked down automatically.



By running the machine backward all grade building or ballast material deposited beside the track is carried between the rails, which then passes under and between wings, and the surplus carried out by ballast spreader wings and deposited outside of rail on end of ties.

Ties can then be raised up through and tamped, and operation repeated until desired track elevation is secured.

BALLAST SPREADER, GRADE ELEVATOR, DITCHER AND FLANGER
 PATENT APPLIED FOR

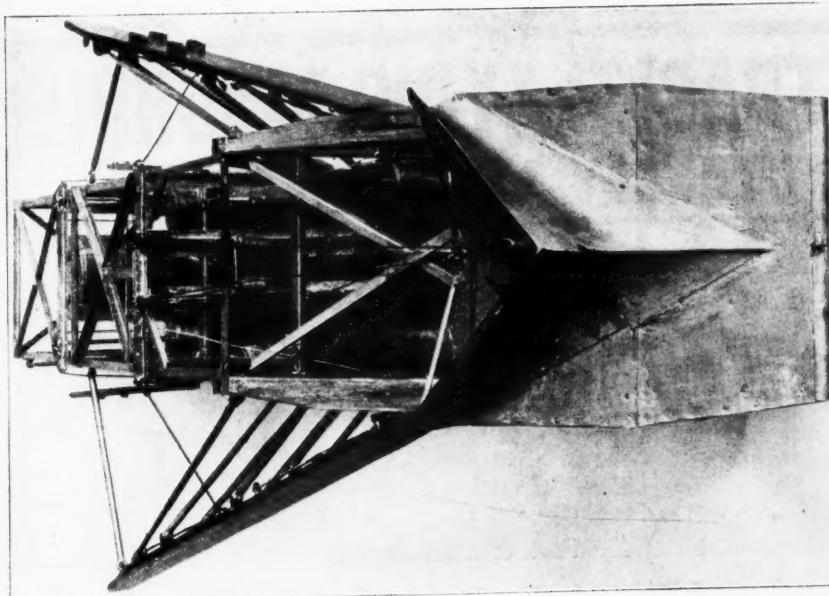


Left wing shows 24 inch plow attached to plow a furrow 4 feet out from end of tie; can be set to throw a furrow in or out.

This plow can be run directly ahead of bank shaper, forming a path for wing extension, throwing material up and in toward end of ties; the bank shaper following immediately after leveling out again and forming a true surface on top and down side of bank.

Can be operated in ten seconds.

The plows can be used for ditching cuts, which will save shimming up tracks in winter and spring where wet spots have formed, owing to slides, etc.



Folding Snow Plow down to working position, front view.

The main wing shown in cut will widen out snow cuts 16 feet wide, 15 feet above top of rail or wider in lower positions.

Wings can be lowered to level position 1 inch above top of rail, in which position a track on either side can be cleared of snow.

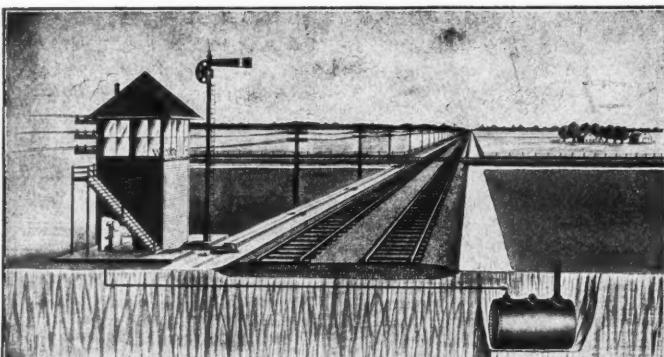
Yards can be cleared of snow by pushing it to one side until it is carried over all tracks and out in small yards, or piling it up from both directions where yards are too wide.

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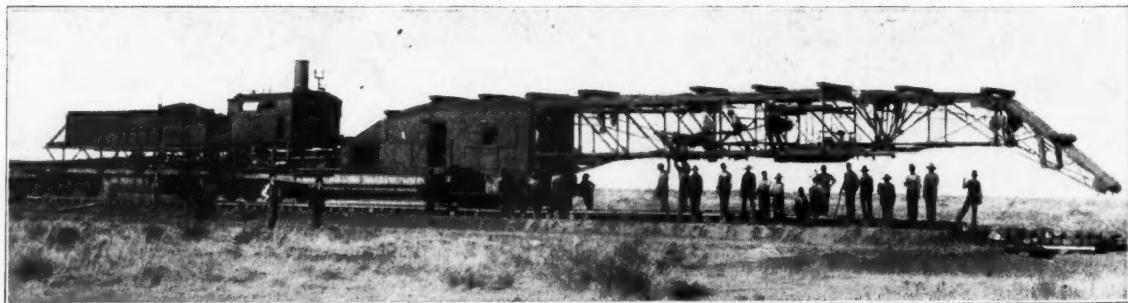
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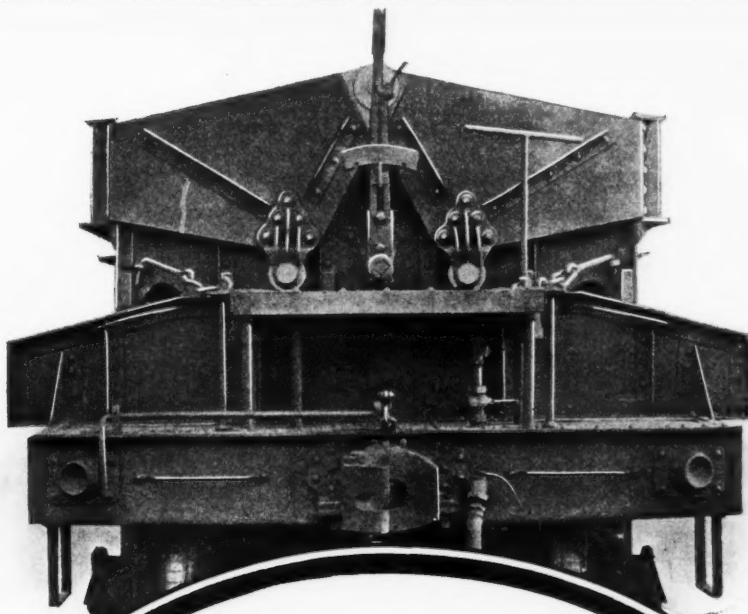
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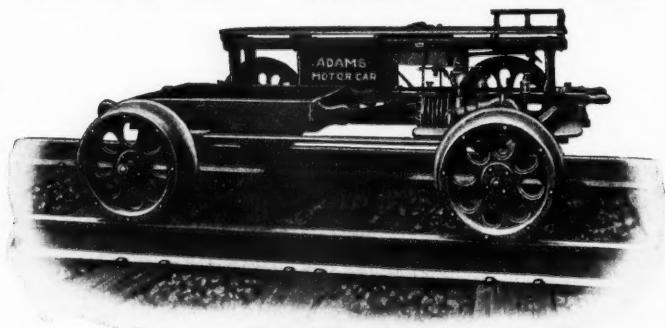
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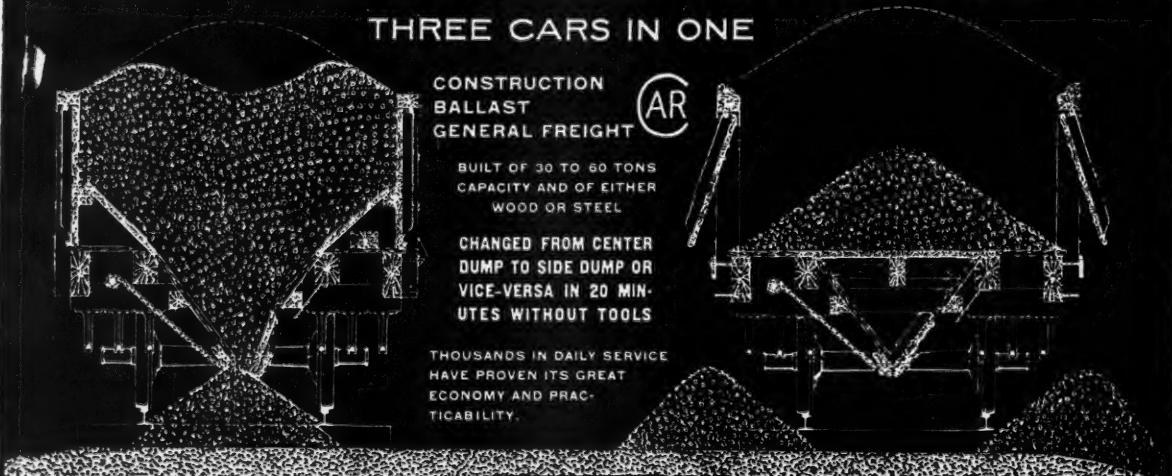
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80 Ton Locomotive	3 $\frac{1}{2}$ inches	145
100 Ton Locomotive	3 $\frac{1}{2}$ inches	165

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Tunnels Particular Subaqueous*

BY MR. R. B. WOODWORTH, M. AM. SOC. C. E.
(Continued from March)

The essential parts common to all large shields operating under compressed air are as follows:

1. The Cutting Edge.—Usually made of cast steel riveted to the shield skin and braced against the first diaphragm by structural steel brackets.

2. The Working Platforms.—Extending out under the cutting edge for use of workmen in excavating, forepoling, etc. These platforms are usually fixed. In the North River Tunnel shield there were eight of these platforms which could be extended 2 feet 9 inches in front of the shield by means of hydraulic rams, independent of the shoving rams, and when extended were strong enough to carry a load of 7900 pounds per square foot, this being equivalent to the maximum combined head of muck and water. These sliding platforms were conceived by Mr. James Forgie in 1894 and first adopted in 1895 under the direction of Mr. Greathead on the shield of the 23-foot internal diameter tunnel of the Waterloo and City Railway, London. They were used in America in 1903 in the shield of the South Tunnel of the Hudson & Manhattan Railroad Company.

3. The Hydraulic Rams.—The rams of the North River Tunnel shield were 24 in number with a net diameter of 8½ inches and a stroke of 38 inches, and were designed for a minimum pressure of 2000 pounds per square inch, a maximum pressure of 5000 pounds and a test pressure of 6000 pounds. The average working pressure was 3500 pounds per square inch. The forward pressure of one ram under a maximum pressure of 5000 pounds per square inch was 275000 pounds; total pressure 3300 tons. The rams were made subject to individual control so that differential pressure might be applied around the shield under the varied conditions encountered, the worst situation probably being the case of a tunnel half in rock and half in soft material. In the East River Tunnel shields there were 27 rams, 9 inches diameter, 3 feet stroke, tested to 9000 pounds per square inch.

4. The Diaphragms and Bulkheads.—The North River shield had only one transverse bulkhead; no air locks or other provisions for maintaining higher face pressure and no material shoots or any discharges other than the nine openings fitted with doors. The East River shields were divided into nine pockets by two vertical diaphragms and two horizontal floors, and in addition to the two vertical diaphragms there were two transverse bulkheads completely closing the shield except for openings made for doors and muck shoots. The object of these two bulkheads was to maintain differential

air pressure. By closing the doors of the forward bulkhead air could be pumped into the shield at a higher pressure than the pressure in the tunnel. The two transverse bulkheads also gave the shield an added stiffness. Great difficulty with this feature would have occurred in material composed part of rock and part of quicksand and the small reservoir of air contained in the shield would have caused great variation of pressure in the event of blows and flooding would have been frequent. As the maximum pressure in the East River Tunnels was only 37 pounds per square inch, this refinement of diaphragms and bulkheads proved unnecessary and some of the material was cut out in order to permit more speedy operations.

5. The Tail.—The Brunel shield had floors in front for the use of the miners and at the back for the use of the bricklayers, and the brick lining was placed as the shield advanced. It is apparent that there is always a possibility of the flowing of material and the dripping of water into the tunnel through the space between the end of the shield and the lining. The tail in the modern shield avoids this difficulty by at all times extending over two or three lining rings, which are erected within the tail itself. The space between the lining and the shield being only 1 inch, very little chance of material entering therein is afforded, and this is to be looked upon as one of the elements of large importance in subaqueous tunnel construction and an evidence of the farsightedness of Sir Benjamin Baker.

6. The Erector.—The weight of one ring of tunnel lining in the North River Tunnel was 23737 pounds, or an average of more than a ton per segment. They were, therefore, erected, as is common in modern tunnel practice, by means of an erector mounted on the shield itself and consisting of a box shaped frame mounted on a central shaft, which revolved in bearings attached to the shield. Inside of this frame was a differential hydraulic plunger 4 inches and 3 inches in diameter and 48 inch stroke. To the plunger head were attached two channels which slide inside the box frame and to the projecting ends of which was attached the grip. At the opposite end was a counterweight which balanced part of the weight of the tunnel segment. The erector in the North River Tunnel was revolved by two single acting rams fixed horizontally to the back of the shield, and with the single erector six rings of tunnel lining have been put in in eight hours. The East River Tunnel differed from the North River Tunnel in having two erectors moving about an angle of 236 degrees each. The erector in the North River Tunnel was operated under 1000 pounds per square inch pressure.

The total weight of the North River Tunnel shield was fully 200 tons; of the East River Tunnel shield 185 tons.

Rate of Progress.—The rates of progress in subaqueous

*Paper read before Railway Club of Pittsburgh.

tunnel practice vary, of course, with conditions. The record for the United States seems to have been made in the construction of the South Tunnel of the Hudson & Manhattan Railroad Company, where large use was made of the method of advancing by closing the shield doors and shoving ahead in the soft silt and mud without excavation, as much as 62 feet being done in 24 hours and 348 feet in a single week. The entire length of the South Tunnel was 5100 feet. It was excavated in 334 actual working days at an average rate of 15.3 lineal feet per day. The four Long Island shields in the East River Tunnels, Pennsylvania Railroad Company, excavated 4195 lineal feet in 120 days, at an average rate of 8.74 feet per day for a shield.

The most serious difficulty encountered in the shield method of construction comes from falls of sand from the face and from blowing out of the cover. The most effectual method to prevent these blowouts is that discovered years ago by Brunel of dumping clay into the chasms caused by the inrush of material and water, though something can be done by heating soft material in advance of the shield to dry it out and make it more stable.

There are three methods of excavation usually employed in advance of the tunnel. The ordinary method in comparatively firm ground of forepoling ahead and of excavating from the platforms; the pushing aside of the material bodily by closing the doors in the tunnel shield and forcing ahead with hydraulic jacks; also that of sluicing the material through the shield mixed with the proper proportion of water. A fourth method was followed in the Rotherhithe Tunnel under the Thames, which was opened to traffic on June 12, 1908. It was built in a little over four years, though the contract allowed 5½ years for its construction. The tunnel, 30 feet in diameter, was driven by the use of two shields advanced from opposite ends of the tunnel. One of these was 5 feet shorter than the other, as it had to work around a long curve of 800 feet radius. The longer shield was built of cast steel segments 60 in number in three rings, the segment in each ring breaking joints with those in the next, and weighed 380 tons. The front portion of the shield was provided with 16 working compartments by three vertical and three horizontal partitions, and the tail of the shield, 7 feet, 3 inches long, was built up of three thicknesses of ¾ inch plates riveted together. The shield was advanced by 40 rams 9 inches in diameter with 3 feet 6 inches stroke, fitted with small internal drawback rams. These rams exerted a pressure of 3 tons per square inch, or about 6000 tons in all, and the lining was erected by two hydraulic erectors, consisting of the usual arrangement of sluing rack, pinion and sliding arm.

From borings on both banks it was thought probable that a bed of clay extended across the river, and in order to obtain definite information a small pilot tunnel was driven across the river in advance of the main heading. This pilot tunnel was 12 feet 6 inches in diameter, lined with cast iron the top being 2 feet below the top of the main tunnel. It was driven with a shield fitted with a rotary excavator of the pattern introduced by the contractors in the construction of several of the London tube railways and in general resemblance to a rotary snow plow. The cutters were of steel and when the cutter head revolved scored concentric curves in the material forming the face. The speaker has called attention several times to the resemblance between shaft sinking by approved modern European methods and subaqueous tunnel driving, and would respectfully suggest that this method of a rotary cutter might be further extended and that a large size subaqueous tunnel might be constructed with the boring machines used in sinking deep shafts through water bearing strata.

Lining.—Since the days when Greathead built the Tower

Tunnel practically all subaqueous railroad and passenger tunnels have been lined with cast iron. The Thames Tunnel, built by Brunel, was lined with brick in cement by bricklayers who placed them directly from the platforms of the tunnel shield. The bricks were thus laid as the shield advanced, nevertheless there was always an unprotected space between the brick lining and the shield through which water and slit might pass into the tunnel. The Severn Tunnel and

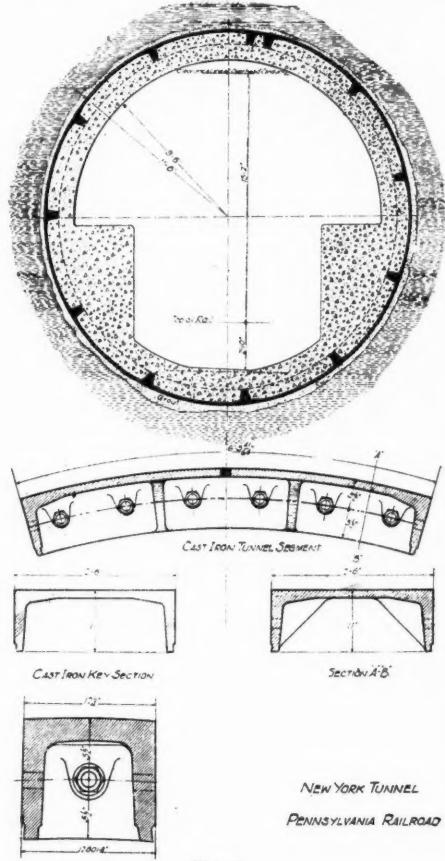


Fig. 9.

the Mersey Tunnels, built in 1873 to 1886, were also lined with brick laid in cement, but these two were rock tunnels—subfluvial but not subaqueous.

Apart from its longitudinal weakness one great disadvantage in brick lining is the necessity for centers on which to construct the arches. These can be made movable, but only serve to crowd space already well filled and in so far to interfere with the progress of the work. In some cases, however, brick lining is most desirable and water works and drainage tunnels are properly lined that way, whether driven with shield or without. The Flushing Tunnel for the Gowanus Canal in Brooklyn, for example, is so lined. This tunnel, 6270 feet long, is circular with an inside diameter of 12 feet and is lined with four rings of brick laid in cement, making a wall 16 inches thick at all points. The tunnel was driven from two headings by the shield method under compressed air at 7 pounds pressure. Each shield was 15 feet long and 14 feet 8½ inches in diameter and weighed, with its jacks, etc., about 55 tons. The length of the shield, was somewhat more than is common in tunnels of approximately the same diameter and the rear end projected 5 feet 10¼ inches behind the back diaphragm to form a tail piece, inside which the brickwork was built. The shield was equipped with fourteen 140-ton Watson-Stillman jacks with automatic drawbacks. These jacks had 8½ inch pistons, 36 inch stroke

and reacted against a heavy cast iron ring which covered the entire face of the brickwork and distributed the pressure over it. This ring was attached to the rams of four of the jacks and when the rams were drawn back after making a shove, they carried the ring with them. The centering ribs consisted of four segments of two 4 feet by 3 inch angles riveted together so that each angle projected a foot beyond the other at opposite ends to allow for joining the segments together. The ribs were circular and both ribs and lagging went all the way around. The bricklayers laid the lagging up to the spring line as fast as they laid the brick, and this protects the green brickwork from damage due to walking upon it. The usual time for two bricklayers to complete a 34 inch ring of brickwork was $4\frac{1}{2}$ hours, so the progress of the tunnel was limited to the rate of setting the brick-work. The average progress of each shield was 11 feet in 24 hours.

Fig 9 shows the cross section of tunnel and detail of cast iron lining of the Pennsylvania Railroad's New York Tunnels. This lining is of the usual type as developed in the light of experience and may be considered as the embodiment of modern tunnel practice. In addition to the standard cast iron lining, cast steel rings of the same dimensions were provided for use in a short stretch of the tunnel when passing from rock to a soft ground foundation, where it was anticipated that unequal settlement and consequent distortion and increase in stress might occur. The rings were 30 feet wide and composed of 11 segments and a key. Each segment weighed approximately 2020 pounds and the key 520, the total weight being 9102 pounds per lineal foot of tunnel. Each segment is stiffened to resist the back pressure of the jacks by two ribs on each side. These ribs do not come into any fixed relation to the rams, but the ram pressure is applied through the heads over at least one rib at any possible position.

Just as in coal mining operations the size of mine timbers is fixed by judgment and experience, so the thickness and form of the cast iron segments seem likewise in the ultimate analysis to be based on experience rather than on mathematical calculation. The lengths of the rings in the Tower Subway was 18 inches, in the St. Clair Tunnel $18\frac{1}{4}$ inches, in the City and South London Railway Tunnel, 18 inches, 19 inches and 20 inches, in the Hudson Tunnels of the Hudson & Manhattan Railroad 20 inches and 24 inches; in the Blackwall Tunnel the length was increased to 30 inches and the same dimension has been followed by the Pennsylvania Railroad. The length is a matter of convenience. The longer length means a greater shove of the shield, less time spent in moving equipment and consequently greater economy in construction. The longer length, however, means increased weight of segments, greater thickness for the same strength and heavier erecting equipment. It has been said the thickness is a matter of experience. This is borne out by the history of the Hudson River Tunnels of the Hudson & Manhattan Railroad. The cast iron lining at the start had an inside diameter of 18 feet 2 inches and an outside diameter of 19 feet 6 inches; each ring was 20 inches wide, composed of 9 segments and a key. The segments were $1\frac{1}{4}$ inches thick in the web, with flanges 8 inches deep and $1\frac{1}{2}$ inches thick, and the joints were not planed. On account of the appearance of serious weakness a new and heavier lining was substituted after 286 rings were in place. In the new type all joints had planed faces, the ring was composed of 11 segments and a key and the thickness was increased to $1\frac{1}{2}$ inches with 9 inches depth of flange. 380 rings of this type were placed when the design was again changed; the depth of flanges was reduced to 8 inches again, the web remained $1\frac{1}{2}$ inches thick, but the flange thickness was increased to $2\frac{1}{4}$ inches.

One of the recommendations of the cast iron segment has

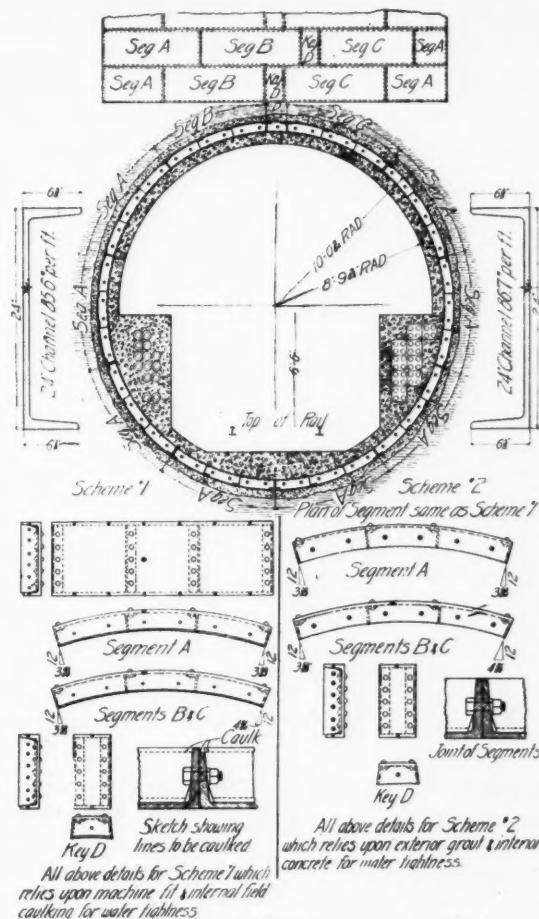


Fig. 10.

been the cheapness of the material of which it is made. This cheapness is offset in modern practice by the machine work on all four sides necessary to provide the fineness of workmanship demanded by consideration of watertightness, and endeavors have been made to devise some means to avoid it. As noted, in the first Hudson Tunnel work the joints were not faced and this probably constituted one element of structural weakness. Henry Japp, Managing Engineer of S. Pearson & Son., Inc., has covered by letters patent a pressed steel tunnel segment of large merit. Pressed steel equipment has not yet, however, reached the development necessary for the production of so accurate workmanship, and the equipment suitable for this work would of necessity be heavy and expensive. Moreover the segments would either need to be short, which would mean more time in erection, or if the same length as the cast iron, would need to be stiffened by angle iron stiffeners to resist the ram pressure.

Structural shapes and plates, however, are the logical successors of cast iron in building construction and it is confidently believed that a steel segment can be designed economically to replace the cast iron. This confidence is based on the fact that steel is a material of universal application in building construction, that it possesses strength and stiffness and has been employed in lining mine shafts in place of cast iron tubing and, therefore, in vertical tunnel construction if not in horizontal. Such a design is shown in Fig. 10 and its basis is worth some attention. The tunnel lining is subject to stress in three general directions—transversely as a tube to resist the weight of superincumbent material under hydrostatic head, longitudinally as a beam under bending moments due to inequalities in the excavation, differences

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in material, etc., and longitudinally also as a column to resist compressive stresses due to the lack of back pressure of the rams.

Considered as a thin walled tube subject to a uniformly distributed internal pressure which would tend to split it longitudinally, such as would be produced by a weight of superincumbent material under hydrostatic pressure, the thickness of lining required for a tunnel 20 feet in diameter under 100 feet hydrostatic head would be, on the usual assumptions as to ultimate tensile strength with a factor of safety of 4, .056 inches for cast iron, .44 inches for wrought iron and .33 inches for medium steel; with a factor of safety of 8, .2112 inches for cast iron, .88 inches for wrought iron and .66 inches for medium steel.

The longitudinal stresses due to inequalities in settlement are in the nature of the case indeterminate, but are beyond question small in comparison with those due to the hydrostatic pressure applied transversely. They are resisted by the bolts connecting the tunnel rings and it appears reasonable that if the number of bolts fixed by experience in the cast iron lining is ample, it will not be necessary to use more in the steel. Moreover, in the steel the stiffeners extend clear across the segment and lend to the ring their tensile strength and stiffness, while in the cast iron lining the ribs are not continuous and there is no strengthening or stiffening of the central portion of the segment.

The bucking of the sections under ram pressure may be prevented either by thickness of metal in the webs of the sections or by the use of stiffeners, it being understood that the packing plates which are placed under the rams will be of sufficient area to produce a uniform distribution of pressure over the web or stiffener. With the web secured against buckling the resistance up to the elastic limit would be equal to the fibre stress multiplied by the web area. The ultimate shear value of medium steel may be taken at 48000 pounds per square inch, elastic limit 50 per cent to 60 per cent of the ultimate. On the basis of 50 per cent the resistance of a 24 inch channel would be 288000 pounds if $\frac{1}{2}$ inch thick, 360000 if $\frac{5}{8}$ inch, 432000 if $\frac{3}{4}$ inch. If stiffeners be omitted the safe resistance of the web at 24000 pounds against buckling will be 160400 pounds if $\frac{1}{2}$ inch thick, 241400 if $\frac{5}{8}$ inch, 322200 if $\frac{3}{4}$ inch. Inasmuch as the maximum forward pressure of one ram in the Pennsylvania Railroad Tunnels was 275000 pounds, it will be seen that if stiffeners are so arranged that one stiffener at least comes under each ram, $\frac{1}{2}$ inch web thickness will be sufficient, and if no stiffeners are used, the steel need be but 11-16 inch thick; and that, therefore, a 24 inch channel with a $\frac{5}{8}$ inch web stiffened by heavy angles will be ample construction under ordinary conditions. The same conclusion is reached from the fact that the cast iron lining 1 $\frac{1}{2}$ inches thick has proven satisfactory in a number of tunnels and it, on the same basis of calculation, is only good for 296600 pounds. The elastic limit loads are used in this calculation as against the maximum ram pressure; the working pressures and the unit stresses, therefore, are much less. The use of stiffeners also strengthens the steel segment in the center, where the cast iron is weak.

Watertightness.—Outside the mechanical fit of the cast iron segments watertightness is effected by methods of grouting and caulking. A certain proportion of the segments are tapped with 1 $\frac{1}{2}$ inch holes closed with screw plugs. Through these grout is forced under pressure to fill the space between the lining and the excavation. Care has to be taken in grouting to prevent contact with the tunnel shield, as the filling of the space between the lining and the shield will cause the latter to freeze fast or else impede its movements; grout behind the tail of the shield may also impede progress by increasing the friction. In the East River Tunnel, Pennsylvania Railroad, a modified quick setting natural cement manu-

factured expressly for this work gave the best satisfaction. Grouting behind the lining is necessary only in firm material or rock; in silt or fine sand the small cracks are soon filled with the silt or sand and further passage of water prevented. The clay blanket has the same effect when in contact with the lining.

Most cast iron linings are made with a caulking space usually machined on their outer faces. Where two rings or segments bolt together these spaces form a continuous groove, which is filled with caulking material driven home with a tool. The rust joint mixture of iron filings and sal-ammoniac, in the proportions of 400 to 1 by weight, is in common use for this purpose. The plan approved for the first Hudson River Tunnel called for the placing of strips of creosoted wood between the longitudinal flanges of the segments. In the East River Tunnels of the New York Rapid Transit Railway, 16 feet 8 $\frac{1}{2}$ inches in diameter with 22 inches cast iron lining rings, the joints were caulked by driving a lead strip tightly into the bottom of the groove and filling up the rest with rust joint mixture. Lead wire caulked cold was also used in the East River Tunnels of the Pennsylvania Railroad.

Tunnels are built with and without concrete lining. In the case of the Pennsylvania Tunnels the cast iron segments were lined with concrete to insure permanency, to strengthen them further against outside pressure and to guard against accidents. This concrete was placed with side benches to keep the trains in the center of the tunnel in case of accidents, and to furnish sidewalks for the workmen employed in track and tunnel maintenance.

Watertightness may be effected by two methods; first by a machine shop fit of the segments caulked with approved rust joint mixtures assisted by exterior grouting, as is the common practice, or second, the segments may be fabricated in accordance with bridge shop practice, so as to reduce their cost, and lined with concrete waterproofed by customary methods, assistance being given also by external grouting. Both of these methods are allowed for in the design of the steel tunnel lining. Whatever method of watertightness is followed, the tunnel segments should be rotated in erection so as to break joints and to prevent the intersection of four joint lines at one point and the bolts connecting the joints should all be drawn up tightly, as the tightness of the joints affects the watertightness of the whole structure.

The advantages of steel for tunnel lining as compared with cast iron are obvious. Sections of the same size and strength are much lighter and, therefore, more economical in transportation, handling and erection. Sections of the same weight would be longer and rings can be assembled with fewer pieces. Rolling processes being much more perfect than casting, machine work may be dispensed with and the segments made by ordinary fabricating methods. The toughness of the steel obviates breaking of segments due to uneven movements of the shield and the expense of their removal and replacement. The use of steel permits also the use of field rivets and in consequence the making of more nearly waterproof joints without caulking. Thirty feet of steel lining has been experimentally installed in an 8 feet 8 $\frac{1}{2}$ inch tunnel of the Hudson & Manhattan Railroad. It is confidently expected that the advantage seen in the erection will be further amplified by service.

Pile Foundations.—The Pennsylvania Railroad plans contemplated the use of screw piles placed through special bore segments to sustain the tubes at points of low stability and to prevent the tendency of the tubes to rise by reason of its buoyancy. Only one, however, seems to have been driven as an experiment, as experience showed they were not necessary. Foundation bents were, however, placed through the lining in the reconstruction of the East River Tunnel of the New

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York Rapid Transit Railway through the fine sand region some 1200 feet long. These foundation bents spaced about 50 feet apart longitudinally consist each of two concrete-filled tubular steel piles 20 inches in diameter, $\frac{1}{2}$ inch thick and spaced 7 feet 0 inches transversely. These piles were sunk into hardpan or rock by jetting through a 4 inch pipe embedded in the center of the pile, were filled with concrete while being sunk and afterwards were capped with a concrete cradle formed around the bottom of the tunnel shell. The bents have been sunk to depths varying from 10 to 50 feet, the jet being assisted where necessary by hydraulic jacks butting against the roof by means of distributing timbers. The whole construction is one of the most permanent character and another proof of the wide extent of subaqueous tunnel construction.

Tunnel construction is not child's play. In its modern extent it demands engineering and executive ability of no mean order. Accurate knowledge of geological conditions and civil engineering skill must be combined with large mechanical ex-

perience and mastery of transportation methods to produce the most economical and permanent results; above all is there a place for rational use of the modern materials of construction.

The material for this paper has been drawn largely from the issues of the technical press for the last five years, chiefly the Engineering News, Engineering Record and Engineering and Mining Journal. Reference has also been had to D. McN. Stauffer's Modern Tunnel Practice and to the description of the Pennsylvania Railroad's New York Tunnels in the September, October and November, 1909, issues of the Proceedings of the American Society of Civil Engineers. The author claims no originality for the material; it has been his purpose to sort, classify and digest for the use and guidance of any master tunnel builder who may come after him. Perhaps it may assist some such builder in the construction of subaqueous tunnels under the Allegheny and Monongahela Rivers as a part of the rapid transit system of future Greater Pittsburgh.

The Maintenance of Way Convention

The eleventh annual convention of the American Railway Engineering and Maintenance of Way Association was held in the Congress Hotel, Chicago, at 10 a. m., Tuesday, March 15, with President William McNab, principal assistant engineer of the Grand Trunk Ry., presiding. Immediately after calling the session to order, the president delivered his address.

Secretary Fritch reported receipts of \$19,758.08 during the year, and expenditures of \$21,203.40; cash on hand, \$16,403.01.

Rules and Organization.

The committee on Rules and Organization was called first. Chairman Jos. O. Osgood, chief engineer of the Central R. R. of New Jersey, presented the report. In the discussion, Mr. C. E. Lindsay, of the New York Central & Hudson River R. R., emphasized the need of having men in training for section foremen.

Whether or not foremen should be allowed to compare watches with trainmen other than conductors to obtain standard time was discussed. Several members said that it was their practice to permit foremen to obtain time from any trainman, as all trainmen are required to keep correct time. The report of the committee as finally adopted reads: "Foremen must provide themselves with reliable watches, and when possible, compare time daily with a standard clock or with conductors' watches."

Mr. L. S. Rose, of the Big Four, wished to modify the rule governing track inspection so as to omit roads of very light traffic from the requirement of daily inspection. The committee accepted a change in the wording of its report whereby such inspection should be required "unless otherwise specified."

Signals and Interlocking.

The report of the committee on Signals and Interlocking was presented by the chairman, Mr. A. H. Rudd, of the Pennsylvania. The scheme of uniform signaling which comprises the body of the report is the same as the one presented last year, with some slight modifications, and also the same as that rejected by the Railway Signal Association this year. As formerly, the committee was divided and both majority and minority reports were presented. The majority submitted the defense of its scheme for the system of uniform signaling:

There seems to be a grave misapprehension among railroad men at large as to the objects of the report and the results which would ensue should it be adopted. As the committee has frequently stated, evolution, not revolution, is intended and advocated. Present practices are not, and cannot be, discredited, for they are good. Of course, taking the country over, there are some methods which might be improved, but

as a general rule, the systems prevailing are those which the railroad managements have found by experience adequate and fitted to their needs. Doubtless many roads require more interlockings and a greater number of automatic block signals, for instance, than they have so far been able to install, but the general trend would be to continue installing them in accordance with the practice which each road has found satisfactory. Our object is not to make radical changes in these practices, but so to modify them that they may eventually result in a uniform system the country over. This can only be accomplished after a long term of years; does not involve sudden or extensive changes; and would be slowly evolved by the use of the recommended aspects for all new work and renewals. While uniformity in signaling is not absolutely necessary, it is conceded by all to be highly desirable.

It is obvious that if uniformity is to be secured, the roads must adopt uniform practice, and should they elect so to do, it should be thoroughly understood that such action is taken solely for the purpose of uniformity, the advantages of which were pointed out in the proceedings.

The government has required the equipment of rolling stock with automatic couplers and continuous brakes; the railroads, recognizing the advantage of uniformity, have provided certain standards. Such standards are practically a necessity on account of the interchange of cars. The situation in signaling is somewhat different. The reason for uniformity is not so much a matter of safety as it is of convenience, and chiefly of economy, as only by adopting uniform aspects can uniformity of apparatus be attained.

The position of the committee is fully set forth on pp. 55 and 56, Proceedings, Vol. 9, but it seems necessary to reiterate this position to avoid misunderstandings and misconceptions of the scope of this undertaking. Several very good schemes have been considered, but the committee, after patient and painstaking labor, is fully convinced that they were (and will, as our railroad development progresses, prove more and more) inadequate to meet all requirements.

The board of direction instructs that "The advantages and disadvantages of the present and recommended practices should be set forth."

Present practice is so diverse that it is difficult to cover it in condensed form. However, it may be stated that at the present time there are three well-established types of automatic block signal aspects. The one-arm two-position semaphore or single-disk signal; the home and distant system, either with semaphores or disks, and with either both arms or disks apart

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dependent upon the exigencies of traffic; and the one-arm three-position semaphore. The single-arm system is most generally installed on lines of light traffic, each signal being a home or stop signal, and each governing to the next signal, but with the circuits so arranged that if, on account of track curvature, fog, or other obstructions of view, the engineman cannot see the signal in time to stop at it, he may with safety overrun it, a distance not exceeding the length of the overlap; or, stated somewhat differently, while he must make every effort to stop at the home signal, the actual danger point is some distance beyond it. The home signal in such a case becomes in a way a distant signal, with the point at which he must stop or cause disaster beyond it. This method avoids the expense of distant signals, but has the disadvantage in frequent cases of practically forcing the engineman to pass a stop signal. However, it is amply sufficient for the needs of important roads and actual practice shows that it is satisfactory in operation.

The home and distant signal system practically places the overlap in the rear of the signal in that the distant signal gives advance information of the condition that may be expected at the home signal which is located at the danger point, or entrance to the block. The distant signal at caution informs the runner that he must get under such control that he can stop at the home signal, although by the time he reaches it, it may have changed to clear through the passage of the preceding train from the block it protects, and in the clear position informs him that he may proceed, without reducing speed, and may expect to find the home signal at proceed. The committee endorses this practice as proper, safe, and desirable, as it gives advance information to which an engineman is entitled. It is admitted that the engineman must observe each signal and keep a sharp lookout, so that if from any cause (such as a switch opened after he has passed a clear distant, a derangement of the signal apparatus, a wreck on an adjoining track fouling his own, or any like occurrence) the home signal indicates stop, he may obey it as quickly as possible. It is held by some that this practice is dangerous, and that the distant signal should not be so used, but if indicating caution the train must at once reduce speed prepared to stop at any obstruction short of the home signal, even if the latter is located a mile away, and if indicating proceed shall not give the runner any right to assume that the home is at proceed, but shall simply show a clear track to the home signal.

The third method of using a one-arm three-position signal carries into effect the home and distant principle, but instead of employing two two-position arms, one three-position arm is used. This method is more economical of installation and cheaper to operate and maintain, especially with types of signals lately designed and is endorsed by the committee for new work and renewals for the reason that it embodies all the advantages of the home and distant system at a minimum cost.

Disk signals are used on a number of roads, the principal advantages aside from low operating and maintenance cost being their distinctiveness from the semaphore, indicating to those governed by them that they may stop and then proceed, while the semaphore at stop indicates stop (and stay). The advantage of this distinction was early recognized by this association (see Manual for 1907, page 159), and the committee has provided it by the staggered lights in the final scheme or the number plate.

In view of the preponderance of sentiment throughout the country in favor of the semaphore, and the increasing numbers being installed, they have been recommended for the uniform system, although the advantages of the disk signals have been fully considered.

The committee then has not attempted to dictate new methods of operation, or specify the especial use of a signal as embodied in the practice of a few roads, but has considered the country as a whole, and has in the automatic work made rec-

ommendations which involve the least change in practice of by far the greatest number, and it has been demonstrated by actual practice, where the new system has been tried in whole or in part, that the proposed automatic signals can be installed in stretches between the old types without danger, confusion or delay to traffic.

As to the aspects themselves, general practice is a one-arm home with arm either square or pointed, either two or three-position, usually with a number plate; or a two-arm or disk home and distant with two lights. The committee recommends the one-arm three-position semaphore with number plate through the transition period, the final proposition being one pointed arm, three-position, with a red marker light at the left of the mast, making a distinction from the interlocking signal clearly displayed by night as well as by day, and providing a stop signal if the active light is extinguished.

There are various arrangements of interlocking signals, one, two, three, and even as high as five arms being used on a mast, each arm as a general practice being two-position. Some roads using two-position signaling make some interlocking signals three-position, the middle position admitting trains to an occupied block. Three-position signaled roads generally use the middle position for indicating that the next signal in advance is at stop. However, without exception, as far as the committee knows, the top arm on a mast governs the through or high-speed route, and the second arm, some or all diverging routes. That is, throughout the country, the top arm, whether on a manual block, automatic or interlocking signal, governs the through track, and diverging routes are indicated in every case by separate arms lower down the mast. If two arms only are used on any road, the lower arm governs to all diverging routes; if more than two arms are used, the second generally governs to the route of secondary importance, usually with traffic, and a third arm against traffic, into yards, etc. This principle in universal practice the committee endorses and carries out, recommending, however, that on account of the long, flat turnouts becoming increasingly numerous in modern track layouts, the second arm should govern over such turnouts which may be taken with medium speeds, and that the third arm should be assigned to govern over short turnouts or over routes which require slow speed, such for instance as against traffic, into yards, or spur tracks, etc. This, in principle, is the practice today where three arms are used; the committee defines the meaning and supplies what it conceives to be an omission in the Standard Code, which does not provide, in so many words, for a divergence from the main track. It will be seen, therefore, that in the interlocking as well as automatic work the committee adheres to general and ordinary practice. It has been pointed out that the general (though not universal) practice on roads using the permissive block, is to give the indication "Proceed—block occupied," by the middle position of the semaphore arm. This indication is, of course, not given in automatic signal limits. The committee retains this position, but provides a distinctive aspect, it having developed that it is advantageous to make some distinction between this aspect and the one indicating "Proceed—prepare to stop at next signal." As the American Railway Association provides for the use of the permissive indication, it has been transferred from its former assigned place among the secondary indications and aspects to the primary table.

Three innovations have been recommended: first, the use of the middle position of the interlocking signal arm to give the same indication as the same position of the automatic signal arm, namely, "Proceed—prepare to stop at next signal." This is the practice on roads using three-position signals in automatic territory and removes one of the inconsistencies of general practice, namely, displaying the distant signal at caution, the home signal at clear, and the advance signal at stop, and provides that if the advance signal is at stop, the home, as well as the distant, shall indicate caution. The second is the use of the middle position of the low speed arm to ad-

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vance a train through an interlocking with track occupied, which can only be done with slotted signals, at present by hand signal, although several roads using both semaphores and disk signals advance trains in this way by clearing the home signal which indicates position of switches, with disk signal at stop, this being treated as automatic. The third innovation is the "continue" indication to cover a switchstand showing main line switch closed, but not giving any indication as to occupancy of track, and to provide for "block office" closed, an indication which is needed, and for which the practice is very diverse, it being generally admitted that some improvement is desired.

Summing up then: First—The table of primary indications recommended for adoption. There is nothing in this table not employed in general practice except 8-10-11-12, limited speed signals, none of which is needed unless long crossovers are in place and being made full use of, and all of which are needed under such conditions; and continue, and proceed at low speed—prepare to stop, the need of both of which is very apparent. Second—The table of primary aspects. The innovations are the marker light, the dotted third arm in same aspect, for use in the rare cases where on steep grades it may not be considered desirable to stop heavy trains at automatic signals; 4-b for block office closed, and the distinguishing mark on the permissive signal, including the use of the new lunar white light at night.

The list of secondary indications has been reduced by consolidation and elimination from that presented last year, and the secondary aspects are presented this year for the first time.

* There is a difference of opinion in the committee as to the requisite indications and a very substantial majority believe that present practice should be followed as closely as possible consistently with uniformity, it being taken for granted that our operating officers are not as a rule giving useless information to their enginemen. In fact, the entire tendency of the American Railway Association in its Standard Code is to eliminate all useless verbiage in its train orders, and leave only the essence. Similarly it can well be presupposed that the indications and aspects in common use are required.

The committee was confronted on the one hand by suggestions for conveying considerable information not heretofore given, and on the other by a similar demand for simplicity of aspect, even at the cost of elimination of necessary indications. It has, it believes, taken a middle ground, and while providing all the information which is necessary and advisable for the safe and proper operation of a large and complicated railroad system, has supplied a path by which the roads of light traffic can, while signaling safely and sufficiently for their needs, lead up to a uniform system without loss of material and labor during the transition stage, the progress being gradual but constant.

The committee has attempted to codify the indications now in general use, and provide uniform aspects for them rather than to eliminate many (on the ground that they are unnecessary) and "simplify" the system by making it incomplete.

The committee recommends that each member of the association canvass the situation carefully on his own road, and be prepared to discuss the table of indications on the basis of such road's present and future needs.

If the American Railway Association should later decide that less indications are needed, those not required by users of the code may be eliminated, while those roads feeling the need of them, are provided with the machinery for their display; this, in the minds of the committee, being preferable to presenting a system so designed as to be incapable of expansion along logical and natural lines.

The reasons given by the minority of the committee for dissenting from the report of the majority are as follows:

(a) This minority report is made only after serious consideration by the members signing it. It is made with a full appreciation of the desirability of devising some plan of uni-

form signaling. Further, it is made with a desire that, when this plan is finally adopted, it shall be in accordance with the best thought, not only of the signal experts of the country, but of operating officials as well. The scheme of signaling presented by the majority, however, represents the opinions of signal experts rather than those of men actually engaged in railway operation.

(b) The minority apparently represents a comparatively small percentage of the total membership of the committee. If examination is made of the interests involved, however, it will be found that eleven roads or systems only are represented, four of which are in the minority. Discussion of the committee's report during the past year has developed a substantial objection to it on the part of signal engineers of the west, by reason of the criticisms we have suggested.

(c) Assurance is given by the majority that the acceptance of the committee's report will only have the effect of selecting such forms of signaling as are deemed best for the purpose of producing uniformity. We, however, respectfully call attention to the fact that the adopted report must, in a measure, define correct signaling practice if it is to have any value whatsoever. It is the first complete scheme of signaling to be submitted to any association. If it receives the approval of this association, and of the Railway Signal Association as well, it will, of necessity, be accepted as the opinion of the signal experts of the country. This fact will not be altered if future investigation develops that the American Railway Association cannot approve the scheme.

(d) There are seven well-defined objections to the scheme of signaling presented by the majority:

First: Two of the four principles, upon which it is based, have been accepted without full investigation, viz.:

(a) The 45 deg. position of the arm shall indicate the position of the arm on the next signal in advance.

(b) The location of the arm on the mast shall indicate the speed at which the movement shall be made.

(a) There is little or no support for the arbitrary use of the 45 deg. position to indicate the position of the arm on the next signal in advance. In present practice, this position of the arm is used indiscriminately for caution signals, whether such caution signals are used for permissive block purposes, for distant signal purposes or for some other purpose. Very little discussion has been given to the correctness of the committee's action in this matter. That it is best to use the 45 deg. position of signal arm to indicate the position of the signal arms in advance, is apparently held by the majority as axiomatic. This question has not been discussed in full committee.

(b) There is little support in present practice for the assignment of the different arms on a mast to different speeds. The three-arm interlocking signal, which is the signal on which the scheme of aspects is based, has always been a route signal. It cannot, in our opinion, be divorced from this function of indicating routes. It is true the association has adopted a scheme for a simple grouping of routes at interlocking plants, based on the allowable speeds at which the divergencies can be made. When this scheme of grouping was adopted, however, it was specifically stated that primarily, routes were to be indicated, and secondarily, as a necessary consequence, speed was to be indicated.

The assignment of the arms on a mast to different speeds, while it has had some study in sub-committee, has never been open for full discussion in full committee.

Second: The scheme has too many aspects and indications which are difficult to remember and understand and will be confusing to the trainmen and enginemen.

Examination of the number of aspects in Exhibit No. 1, which may be used to signal a railroad using one, two or three-arm signals, shows 96 aspects or pictures for the engineer. Fourteen of these give high-speed proceed indications. With the complete scheme, Exhibit No. 2, and the secondary as-

psects, 59 aspects can be used, seven of them giving high-speed proceed indications.

We take the position that a scheme of signaling, embracing this number of aspects, is impracticable and unnecessary. Regardless of the number of aspects shown or used, the engineer will classify certain of them as "stop" signals, certain as "caution" signals and certain as "proceed" signals. He has, in fact, little time to interpret them in any other manner. The engineman of a high-speed train should never be in doubt as to the meaning of a signal if he is to run safely. The signal should mean something perfectly definite to him, which he cannot mistake. In our opinion this result cannot be obtained by the use of the large number of indications and aspects presented by the majority.

When it is attempted to show more on the face of a signal than "stop," "caution" and "proceed" (the indications used by the American Railway Association), complication enters, and doubt is raised in the mind of the employee. To the engineer, too many aspects are confusing and carry the same element of danger as too many train orders. Experience has clearly shown the wisdom of curtailing orders to the minimum length and number, and not burdening enginemen and trainmen with information not of immediate concern, or orders too far in advance of their execution.

Third: While a multiplicity of aspects is provided, they are incomplete. The operation of railroad signals today is based upon the principle that the absence of a signal, where one is usually displayed, shall indicate "Stop." For example: Indication No. 7 (Proceed—prepare to stop at next signal) is equivalent to saying, Proceed—the next signal is in the "Stop" position. The absence of the 45 deg. position or change to the 90 deg. position, gives the engineman permission by inference to assume that the next signal is clear, but this is not covered by an indication. The same criticism applies to other similar indications. In other words, in order to complete a system of signals along the lines presented, it is necessary to provide additional indications.

In the previous list of indications presented to this association by Committee X, will be found the following:

In Exhibit No. 1, outline of indications for method of Uniform Signaling, 1908, "Proceed on unlimited speed route, next signal at proceed," "Proceed on limited speed, next signal at proceed." In Exhibit No. 2, accepted report on committee of signal practice to the American Railway Engineering and Maintenance of Way Association, 1909, will be found, "Proceed at normal speed—prepare to pass next signal at normal speed," "Proceed at limited speed—prepare to pass next signal at normal speed." In the outline of indications presented this year, it will be found that the reference to routes has been eliminated and also all reference to "next signal at proceed" or "prepare to pass next signal at normal speed."

We maintain that when the indications "prepare to stop at next signal" and "prepare to pass next signal at limited speed" are given in a specific way, the indication "prepare to pass next signal at normal speed" is compulsory; that if a specific restriction is placed on the movements of a train, this restriction must also be removed.

We hold, therefore, that the diagram of indications is not complete because it does not provide the converse of its restrictive indications.

Fourth: There is no well-defined basic principle that may be followed interpreting the aspects. The scheme has many interpretations which are not covered by, or in harmony with, the standard code.

The majority scheme is based on the assumption that the top arm should always indicate normal speed movements and the second arm should always indicate limited speed movements; yet, in aspect No. 8, we have the top arm at 45 deg., which should refer to normal speed movement, and the lower arm at 90 deg., which should refer to limited speed movements. The conflict is apparent.

Another inconsistency appears in that either the top arm or secondary arm at 45 deg. can indicate the position of the next signal in advance. Where green is used for "clear," it is associated with a normal speed movement and yellow with a reduced speed or cautionary movement. The majority scheme before you, however, allows a normal or high-speed movement under either a green or yellow light on the top arm, and a reduced speed movement under either green or yellow light on the second arm.

Fifth: There are too many red lights displayed.

The display of red lights on an interlocking signal, when a train can run by it at its usual speed, has always been an objection in the eyes of operating officials. This report, which is presented to bring about uniformity, is based, it will be noted, on the principle that a red light should be displayed to every train on every signal when trains can pass at usual speed.

We believe that this feature of the proposed scheme is a step backward rather than forward.

Sixth: The same aspects are used for different indications and different indications for the same aspects.

Seventh: Definite or precise information of considerable variety not required in the practical operation of a railroad, is provided throughout the scheme. In order to maintain the distinctions, much complication is introduced which may lead to considerable difficulty. For example: Instead of one "caution" signal, there is provided a special signal for each of the several occasions requiring caution. The scheme provides specific information about conditions in advance; notably the indication of next signal. The distant signal is used as a repeater of the home and is bound to teach enginemen to relax vigilance and depend upon advance information, which is subject to change, and, therefore, unreliable. The plan of providing repeaters for home signals will eventually lead to a demand for still further repeaters and checks of various kinds upon fixed signal systems, such as cab signals, and ultimately automatic stops, all of which tend to a laxity in the proper degree of attention on the part of the employees.

It will be noted throughout the report that such phrases as "prepare to stop at next signal," "prepare to pass next signal at limited speed," "prepare to stop short of an obstruction in block," are provided, thus defining the purpose for which reduced speed is necessary.

We feel that any specific reference to the obstruction is conducive to a lack of vigilance, that it is far safer to require reduced speed or caution by some signal display and leave it to the engineman's vigilance to discover what the obstruction is. It is our opinion that, in this way, safer operation will be obtained than if the engineman's attention is attracted away from general supervision and centered on some specific thing. This is aside from the objections to the complication introduced when so much specific information is provided.

It will be noted that, after this report is completed, only two or three reasons for "caution" are specified, and that if any other necessity arises for which a "caution" or reduced speed indication is necessary, more aspects will have to be developed, introducing further complications.

One of the underlying principles of this scheme is that several separate and distinct caution indications should be provided, but until all caution indications which are required have been provided, the practicability of this scheme will not be shown.

The majority has attempted to restrict the use of the present-day caution signal to that of repeating signals in advance. We object to this practice because of the unreliability of the information conveyed. The distant or caution signal is very frequently found in the caution position, when the home signal is found clear on the approach of trains, due to other trains passing out of block ahead, etc. Again, the distant or caution signal is not infrequently found in the clear position and the home signal in the stop position, due to a change in conditions after the train has passed the distant signal. Because

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of these facts, it is obvious that the value of a distant signal as a repeater of signals in advance, is extremely doubtful. In fact, the engineman is not safe in relying upon the information so given and soon learns to place a signal so used in the same category with employees who give violent signals when slow signals would serve the purpose.

Mr. Rudd replied to the minority report as follows:

The committee believes that its report on uniform signaling fully covers the subject and has no additions or further explanations to make. The minority report sets forth certain objections and it is our belief that time will be saved if an opportunity is given the committee to answer these objections of the minority (which has studied the subject probably more carefully than any member outside the committee) as, if we can dispose of them, the way will be cleared for action. The following page numbers refer to pages in Bulletin 119, in which the majority and minority reports were published:

Page 71. It is unfortunate that the minority included paragraphs (a) and (b) in a report to this broad gage association. The statements are really not arguments, for if the system is a good one, the official titles of its sponsors cannot injure it, and if it cannot be commended, no such titles should be used to bolster it up—it should stand or fall on its merits. However, the statements have been made and as they carried considerable weight in the signal association, and as they possibly affected some votes of that letter ballot (which resulted in 235 votes for the report and 311 against it, while two-thirds vote was necessary for its adoption), it devolves upon us to answer them despite our embarrassment, for it now becomes necessary to tell you what a wonderfully well equipped body of experts we are—a fact which should be self-evident to all men of discrimination, but upon which the minority casts a doubt. We apprehend that a chief engineer approving designs for a classification yard has glimmerings at least that it is to be used for the passing through it of cars, and from some of the discussion had here on the subject of momentum grades, for example, it is to be presumed that some engineers at least know something about the requirements of the transportation man; similarly it is fair to suppose that a well-equipped signal engineer must of necessity understand the requirements of the traffic he facilitates and safeguards, and as he makes a specialty of this work, that he is better fitted if he understands his business, to devise a uniform system of signals, than a superintendent, whose desire is to attain certain ends and whose study of the means to attain these ends must perforce in most cases be perfunctory; although it cannot be denied that under the spur of the discussions in this and the signal association some superintendents have given the subject more thought in the past four years than all the superintendents on all the roads ever gave it before. I do not wish to be understood as implying that our honored vice-chairman is disqualified as an expert because he has become a superintendent. We claim that this committee is made up of just such well equipped competent signal engineers as those referred to and we offer ourselves as living proofs of the statement. This committee is composed as follows: Of men who make, or have made until recently, a special study of signaling, majority 14, minority 2; operating men, on whom such stress is laid, majority 3, minority 3; one not signing either report, engineering in close touch with operation, majority 1. These men do not represent any roads or systems in this voluntary organization; they represent their own individuality, untrammeled by instructions of their operating officers, superior officers or any one else. It is true that the Pennsylvania has two men on the committee, the Baltimore & Ohio, two, and the New York Central Lines five, but the fact that these five happen to be employed on the component parts of a great system, which parts have different practices, does not warrant the implication of prejudice and certainly a responsible position on the New York Central Lines is not *prima facie* evidence of mental disability or lack of knowledge, or judgment—in fact, these are the men who are best qualified

to design a uniform system, because they have to deal with the complicated as well as the simple problems of track layouts and signaling. The Pennsylvania Railroad, for instance, has problems in no whit different from those of the western signal engineers. We have approximately, 456 miles of four-track, 110 miles of three-track, 1,230 miles of two-track line, a total of 1,786 miles, and 3,500 miles of single track—two-thirds of our mileage is single track. And, on 445 miles of this we had, a year ago, only from 2 to 10 movements daily and on 525 miles more, from 11 to 18 movements daily. It is true that there is less four-track west of Chicago than east of it, but the western roads are growing and they will soon be confronted with the problems which are now vexing many of the majority members and will appreciate more fully the need of the information we propose to give, and this problem covers the whole country—no east and west issue should be brought into it; and, in fact, some of the busiest four-track road is right around Chicago—and they give in a different way just these very indications.

It will be noted that the minority offers no substitute scheme, but confines itself to criticising. Last year Mr. Stevens presented a scheme and it was illustrated in the Proceedings. Mr. Clausen presented a scheme to the committee, this scheme being discussed at the signal association last March. Neither of these schemes met the approval of your committee. It is fair to suppose these schemes were in the minds of the minority when its report was made. It states that our scheme represents the opinions of signal experts rather than those of men actually engaged in railway operation. Is this a fact? No road, to my knowledge, has adopted the basic principles of the scheme advocated by Mr. Stevens. If I am wrong he will be able to correct me later. No road, as far as I know, has adopted the fundamentals of Mr. Clausen's scheme, and it is in two or three fundamentals only that our differences lie. There is no difference of opinion as to the advisability of upper quadrant arms approved by this association, little, if any, on green for clear, approved by this association, none on the automatic signal. The chief differences are on the use of the mid-position of the home signal arm instead of a second arm to indicate a divergence from the main track, the addition of a permissive indication for those roads who believe they require it, and the question whether the distant signal should be considered as giving the engineer a right to proceed to the home, expecting to find it clear. Is the vice-chairman's own road, which he implies he represents, using his mid-position for diverging routes on new work and renewals? On the other hand, the B. & O. is using the primary aspects recommended by the committee, except the use of green for clear. The New York Central operating officials have endorsed the committee's scheme; at least, to such an extent that they have adopted it for all new work and renewals, with little change. All the new interlockings on the L. S. & M. S. are arranged in this way, and the basis of the system is being used on many others; at least, this is my understanding. Transportation officers of the Pennsylvania Railroad, from general manager down, have, with few exceptions, endorsed practically all the primary aspects (and we have adopted 3-pos. upper-quadrant for new work and renewals on our lines east of Pittsburgh within the past week). Further, we are going to use automatic signals with one pointed arm and two lights staggered; the interlocking signals three-arm, with top arm for high speed, second arm for medium speed, and third arm for low speed; distant signals approaching interlockings will have two arms with staggered lights to correspond with the high medium speed arms on the interlocking signals; distant switch signals are to be of the one-arm automatic type. It would appear, therefore, that some operating officials of good standing approve the scheme.

Page 71. We believe that this argument is sufficiently answered in the body of the report under the caption "Object of the Report," except as reference is made to the American Railway Association. As that association has endorsed the upper-

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quadrant and made optional the use of green for clear, and has never made any rulings on the other principles enunciated in the report which are at variance with the recommendations of your committee, it is fair to suppose that if this system meets the approval of this association, it will have as much chance for adoption, if the A. R. A. sees fit to recommend for adoption any uniform system, as some other which it has not been considered advisable by the minority to submit for your consideration. Certainly if this association should decide not to present any scheme to the A. R. A. for fear it might not approve it, the decision should be made of having annual reports presented on it.

How as to the severe specific objections:

Page 72. (a) The minority states: "The 45 degree position of the arm is at present used indiscriminately for caution signals, whether for distant signals, permissive signals or for some other purpose." This statement is perhaps a little misleading to those who are not experts. It is used perhaps indiscriminately on one or two roads for the distant signal indication and the permissive, but on a number of roads 45 degrees is used for the distant only (at least in the new U. Q. installations), and on most other roads the day aspect for the distant signal at caution, is a fish-tail arm horizontal and the permissive a square end arm inclined downward or upward from the horizontal. So they are not used indiscriminately generally to-day. As to the some other purpose, the minority should amplify. We do not know of any instances where the 45-degree position of an ordinary semaphore signal is used, for instance, as a slow sign for track under repair, which requires caution, nor for diverging from the main track, as advocated in committee by the minority members, and we would be glad to be enlightened as to other purposes for which it is used. The committee recommends its use not as the minority states, for the distant signal indication only, but for the permissive as well, but it recommends a distinguishing mark when it is used for the latter indication, in order that the engineman may know whether he is to stop at a definite point ahead, or look out for a train in a long block moving at perhaps varying rates of speed. While it is true that very little discussion was had on this particular point in the full committee, it certainly had plenty in the sub-committee, and, further, little discussion was needed in the full committee, for, as the minority well states, it was (after consideration) "held by the majority as axiomatic."

(b) On page 57, you will note the indications presented in 1908, where routes were specified; the next year the word route was eliminated by the vice-chairman, who was given the task of correcting the table and bringing it into accord with his watchword, "The action required of the engineman in the control of his train." This year it appears that the original table was right. The revised table is now considered wrong. Ever since the top arm has led to the straight or through route at interlockings, it has, in the clear position, given the indication that the route was set up on which, unless prevented by some other cause, full speed could be maintained, and ever since that time the second arm has meant reduced speed, because the train was going to diverge. Some roads displayed indicators to designate the track and then discarded them. Some roads used three arms, the second arm to govern with traffic and the third against traffic; not because of routes to be shown, according to our analysis, but because they realize it was not safe to give the same signal for different rates of speed; in rare cases four arms were used, if there was a junction with three running tracks. I have never heard of a road having six or seven diverging routes, however, as a four-track joining a four-track, which used eight arms, signaling each route separately; the routes, as the minority say, were grouped, and not only common practice, but the action of this association, gives approval to the arrangement of the top arm for the high-speed route, second arm for medium-speed route or routes, and the third arm for low-speed route or routes, and if it will clear the

atmosphere and simplify matters in the minds of any to add the word route, it can easily be done; the point in our minds is not important enough to require much discussion and we have followed the wording of the A. R. A. The statement that the assignment of arms has not had full discussion in full committee depends for its accuracy on the definition of the word full. The location of arms was discussed in connection with Mr. Stevens' scheme, at the signal meeting last March, and at the meeting of the committee in Philadelphia, at which Mr. Stevens was present. To the best of the chairman's knowledge, both of these matters have been open for discussion at all times in the committee meetings. If they have not had full discussion, the reason is, it is believed, that most of the members were convinced of their correctness and were not disposed to join in prolonged discussion.

Page 72. 2d. "The majority scheme has too many aspects and indications which are difficult to remember and understand and will be confusing to trainmen and enginemen." As the minority does not present its so-called simplified scheme, no comparison can be made, and we are naturally at a disadvantage in argument. It is fair to state, however, that the 96 pictures will probably never appear on any one engine division, and certainly will only need to be read one at a time. In view of the fact that some roads now have, as stated by the vice-chairman in one of the earlier discussions, as high as 125 aspects, at the worst this scheme is simpler; as a matter of fact, the primary aspects consist of one, two or three-arm interlocking signals and an automatic block signal, and a switch target, all in use on the great majority of roads that have any signal installations of any size, a special mark to show permissive block, now shown by a distinctive position of the arm on many roads, slow track and resume speed signs of some kind are almost universally used, and a signal for block office closed is new and needed. If you have no occasion for signals, you would not need any of these aspects.

The minority says, page 73: "The engineer of a high-speed train should never be in doubt as to the meaning of a signal if he is to run safely; the signal should mean something perfectly definite to him, which he cannot mistake." We endorse this sentiment, and yet the simplified scheme presented by the minority for approval of this committee used the 45-degree position of the upper arm when there was a train in the block, perhaps within 300 or 400 ft. of it, when the next signal was at stop; when the next signal was at proceed with a route set up which could be run safely at 40 miles per hour; or for diverge right at the signal, safe speed 40 miles per hour. What a wealth of definite information, all embodied in one aspect! It's like saying that all the letters of the English language are included in the alphabet, and if you say "alphabet" to a man you've taught him the language. If you say caution to a man when caution is not needed, you mislead that man and you set a trap for him. All of you who have had anything to do with signals know that in the days when discipline was lax, a distant signal would be left at caution by a lazy operator, sometimes for all except two or three trains daily, and that engineman so finding it used to disregard it, and when interviewed would say: It's always that way, it doesn't mean anything." The proposed scheme does give just that information which is needed and required by practical men on roads which have reached a considerable development. The simplifying of a system by the process of omission is a poor policy.

Precision vs. Brevity is a fair summing up of the situation, but the minority advocates precision by employing brevity.

The reference to train orders is very apropos, the train orders should be very brief, they must be exact. The application to signaling is obvious and need not be enlarged upon.

Page 73. 3d. No additional indications are necessary. We take flat issue with the minority members. The wording is that of the American Railway Association, to quote:

"Distant Signals—Name as used in rules, Caution Signal; indication for enginemen and trainmen, proceed with caution to

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the home signal; occasion for use:—home signal at stop, route is not clear.

Name as used in rules, Clear Signal; indication for engineers and trainmen—proceed. Occasion for use:—home signal at Proceed route is clear."

Certainly the A. R. A. is more likely to favor its own phraseology than a departure from it, made on such hair-splitting lines, and we eliminated the words quoted by the minority on page 74 for the reason that we desired to follow the A. R. A. wording as far as possible. An arm at 90 degrees giving the indication "Proceed" involves no restrictions by signal indication and is the converse of Stop. Is there any reason why the same unrestrictive indication "Proceed" should not remove other restrictions that might be indicated by other positions of the arm or arms; any reason why it should not be the converse of other restrictive indications than stop—of all restrictive indications that might be given by the particular signal?

Page 74, 4th. In the preceding paragraph we were criticized in following the Code; in this paragraph because it is said we vary from the Code.

We have discussed aspect No. 8 for the past two years, in committee, before the signal association, and here, and further discussion is unnecessary except to present the remedy advocated by the minority in committee.

The committee feel that if tracks are so arranged with long crossovers that a train may safely pass the home signal at 40 or 50 miles per hour, but cannot pass it at 70 or 80 without a bad lurch, the engineer should be warned of the safe speed, but should be allowed to take advantage of his track layout and not be required to reduce speed at the distant, prepared to stop at the home. That is, provided signals are installed to expedite movement and not simply to restrict it as much as possible. The aspect No. 8 they claim is not logical and their suggestions for correcting it is a very simple one. Eliminate the indication entirely—don't tell him he can go when all is right, but tell him to reduce speed prepared to stop at the home signal, because, forsooth, the occasion for use is pass home signal at 40 or 50 miles per hour. This process amplified and logically applied to a home signal, would reduce that to a one-arm signal only & then stop all trains that have to diverge at low speed, and flag by them.

Page 74, 5th.—The committee stands on the principle that in a completed, uniform scheme, there should be two lights on each signal governing train movement, first, as a marker to distinguish between automatic and interlocking or telegraph block, (the action of this association having already asserted that a distinction of some kind is necessary), and second, as a marker, to show the location of the signal if the other light is extinguished at night. If this marker should not be red and display a stop signal when the other light is out, following strictly the rule that a signal improperly displayed is to be regarded as a stop signal, what color should it be? Obviously not green—proceed; obviously not yellow—caution; from our point of view obviously red, and red only. From the minority standpoint of brevity and simplicity, logically eliminate it entirely; but to do this no signal should have more than one light, consequently no diverging low speed routes could be signaled by fixed signals logically.

The Standard Code is admittedly a skeleton and not complete—one of its framers told me less than a year ago that it ought to be amplified and completed. Obviously in a complete scheme we give more indications than in an incomplete one—for confirmation of this statement see any good dictionary. Aspect No. 8 is absolutely consistent, in that it indicates unmistakably the position of the high and medium speed arms at the home signal, and that is what the fast runner wants to know.

Page 74, 6th.—The same aspects are used for different indications and different indications for the same aspects. This sounds as if there were two objections, but both clauses mean the same thing. These variations are incident to the necessity

already shown for information in the other positions of the arm—"the same aspects for different indications," is not an objectionable feature. If, however, these aspects might be misread so as to convey to the engineman a more favorable indication than he should receive, then they would be objectionable. This, however, is not the case.

Page 74, 7th—I will read the first three paragraphs on page 51. If the members have done as the committee requested, they can determine (with this statement of the minority as a guide) whether their operating officials are practical or impractical railroad men and those of you who are operating in an impractical way and who have anything to do with signaling, will perhaps recollect requests from such superintendents for more information rather than less.

The minority claims that the distant signal cannot be relied upon and that it should not indicate next signal at proceed, but should, in the clear position, indicate proceed to the next signal. How? Obviously in the only safe way, if it cannot be relied on, that is prepared to stop. Why then display the caution aspect, which means the same thing? More elimination, more brevity, more uncertainty, more delay, and less safety.

On this basis truly the American Railway Association is composed of members carrying on impractical operation, for the Code says: Distant signal, indication proceed—occasion for use—home signal at proceed. If the minority is correct in its treatment of the distant signal, where does the A. R. A. stand? The minority believes it is on firm ground.

How many of you are ready to do away with distant signals where high speed is required, and how many are ready to say to their engineers: "A home signal at stop means stop." A distant signal at caution means "prepare to stop any point beyond this signal." And the distant signal at clear "you have a clear track to the home and our apparatus is arranged to comply with A. R. A. requisites, so that in case of failure it will indicate caution, but nevertheless you mustn't place any dependence upon it, because it is unreliable?" In the three-position automatic system the distant and home are combined in one arm. Are you prepared to say: "When the automatic is clear, reduce speed at once, the block is clear, but we don't rely on the indication?" Interlocking has been known to fail. Must a man prepare to stop at each clear home signal and feel his way? We endorse present practice. Do you say it is all wrong, dangerous, subversive of discipline, and that it, by its encouragement of lax discipline, will lead to the use of cab signals, automatic stops, etc.? You have the word of the minority, three of the four men being operating men of note, that discipline cannot be maintained if this use of the distant signal is allowed.

The issue is clean cut. It means that you cannot discipline a man for passing a home signal and that your men will become careless and disregard the home signals, unless you require them to reduce speed so that they may stop at any point within vision beyond the distant signal and this on a crooked road. And this is the deliberate, considered opinion of the three operating experts of the minority. The committee states that most roads to-day use the distant signal in precisely the way condemned by these experts and asks you if discipline is lax; whether your men under this practice disregard your home signals and whether you will, by your votes, endorse the position of the minority, or will back up your committee, in the light of your experience, bearing in mind the fact, gentlemen, that signals do not enforce discipline; that duty devolves upon the officials in charge of transportation. Page 76—in conclusion—in recommending a portion of the report for adoption the committee considered that this portion, covering the primary indications and aspects, had been worked out to a conclusion through several years of study and discussion during which no radical changes had been made. In the case of the secondary indications and aspects, embodied in the progress report, various schemes have been under discussion and the one presented was developed and agreed to within the past

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year. It therefore seems advisable to allow more time for consideration and possible revision before final action is recommended.

The only question affecting the wisdom of adopting a portion of the report, as recommended, seems to be, whether revision of the secondary system might make changes in the primary system necessary. On this point the committee feels no fear whatever. The report shows that a practical secondary system, in harmony with the recommended primary system, can be devised and the primary system is so well established that, beyond question, any desirable changes in the secondary system can and will be so made as to require no revision of the primary system.

The two following paragraphs the committee accepts as axiomatic. Read them. The system recommended will certainly help to bring about the condition stated in the first and involves no added mechanical or electrical complications that could result in an increased number of failures and false indications as compared with good signaling of the present day.

The minority says "any system which says any signal indications that a clear block signal means that the 'Block is clear' of necessity encourages laxity." The A. R. A. Code says: Clear Signal—Proceed. Occasion for use—Block is clear. Which is right? What use are block signals under the interpretation of the minority?

Evolution not revolution, is the object of this committee and we believe this association. Where is the minority position short of revolution?

In the second paragraph on page 77, the minority defines what a consistent uniform system should cover. The committee agrees with this basis and submits its system as designed in conformity with it.

In conclusion: Attention should be given to the fact that only a part of this report is submitted for acceptance, the remainder being submitted as a progress report. It is manifestly undesirable for this association to accept part of the report unless the whole scheme has been developed and the majority can show that they are able to take care of the situation.

When enginemen and trainmen can be taught implicitly to respect and place entire dependence upon signal indications given them then, and then only, will railroad companies, their passengers and employees receive the full measure of protection available through the use of signals.

If failures and false indications are numerous to that extent unquestionably will the entire system be discredited. Operating officers throughout the country will, undoubtedly, disown any system which tends to encourage laxity.

Any system which says by signal indication that a clear block signal means that the "Block is Clear," of necessity will encourage laxity. An engineman with this conception of the meaning of a clear block signal will not keep the sharp lookout that we must insist upon to have safety in operation. The block may not be clear. We cannot guarantee that it will be. There are many ways in which it may be obstructed, such as by runaway cars, damaged bridges, rock and dirt slides, etc.; and various others too numerous to mention. All of these obstructions must be expected without advance information, hence the imperative necessity for vigilance at all times. The clear signal should not mean "Block is Clear," but "Proceed" only.

A simple and consistent uniform system should provide fixed signals as close together as traffic conditions may warrant. Safety in operation demands that all signals be read in the order they are met and the action taken at the signals instead of at the next signal or at the next station.

After considerable discussion by T. S. Stevens, of the Santa Fe, L. R. Clausen, of the Chicago, Milwaukee & St. Paul, and others, it was voted to refer the subject back to the committee, with instructions to confer with the signaling com-

mittee of the American Railway Association, to see, if, after such conference, the committee could agree on a report.

The report on standard agreements for joint interlocking plants, effect of treated and metal ties on track circuits, switch stands, records and accounts, on symbols, and electrical and mechanical specifications, was accepted as a progress report.

Electricity.

The committee on electricity presented a progress report only. Third-rail working conductors had been discussed, and while no conclusion was reached as to the clearance which would be advisable, it was the opinion of the sub-committee that the clearances between the limiting lines of equipment and the limiting lines of third-rail structures, shown as $1\frac{1}{2}$ ins in the American Railway Association report, are not sufficient and that a greater clearance should be established. To determine the limiting clearance that could be established it was decided to secure data from different railways on limiting lines of clearance of third-rail conductor structures, limiting lines of rolling equipment and limiting lines of third-rail structures with respect to maintenance of way structures. The sub-committee is also collecting data from electrified or partly electrified railways, and also interurban lines with heavy traffic, which might possibly wish interchange traffic with steam lines partially or not electrified. This sub-committee is communicating direct with the representatives of the various railways, and has issued a circular requesting data pertinent to these subjects.

No meetings of the sub-committee on transmission lines and crossings had been held, but the members had corresponded with one another. Communications were sent to the committee on power distribution of the American Street and Interurban Railway Engineering Association, sub-committee on overhead construction of the National Electric Lighting Association, and Committee No. 1 of the American Railway Bridge and Building Association, suggesting the advisability of the various associations co-operating. Copies of crossing specifications were requested from various companies. It is intended to make a report of comparison of these various specifications.

Conservation.

The special committee on co-operation with the National Conservation Commission in a progress report recommended that:

This association do all in its power:

To obtain systematic co-operation of railroads with federal and state authorities in the abatement of forest fires, whether originating from railroad locomotives or from other causes.

To devise efficient spark arresters.

To enforce proper stoking.

To place on the operatives, especially section foremen, responsibility for keeping rights of way clear and combating fires which do start.

To bring it about that railroads own and manage timber lands for the production of ties and other wood needed by them. That these forests be managed, and extended by artificial means where necessary, by trained foresters. The general introduction of sawed instead of hewed ties. The general use of other woods than white oak. That the railroads adopt the policy of treating with preservatives all ties, piles, construction, and other timbers which are subject to destruction by decay or marine borers.

That efforts be made to secure such improvements and economies in the construction and operation of by-product coke ovens as will lead to their general substitution for the beehive type.

That tests be made to determine the relative efficiency of oil tar creosote and coal tar creosote as preservatives of wood.

That tests be made to determine the minimum quantity of oil of a specified grade necessary to preserve wood under given conditions.

That tests be made to find satisfactory substitutes for creosote in the treatment of timber.

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Iron and Steel Structures.

The report of the committee on iron and steel structures was presented by the chairman, Mr. J. E. Greiner. The recommendations of the committee were divided into two parts, group 1 covering minor changes in the manual, such as corrections of punctuation, etc.; and group 2, which included important changes in the manual which affect the substance. Group 1 was adopted without discussion. The paragraphs of group 2 were read, one by one, inviting discussion, but little or no discussion was offered, and the changed paragraphs were adopted in the form proposed by the committee.

Conclusion No. 2 had reference to the care of bridges, and the following clauses were adopted as proper to include in a system of bridge inspection:

(1) Inspection by the regular section forces daily, or as often as they inspect the track under their supervision. The object of this inspection is to discover any damage to the structure from fire, flood, derailments or other accidents from traffic, or any displacement in the structure in whole or in part. This inspection, due to the lack of skill on the part of the section forces, must necessarily be superficial, and will rarely, if ever, do more than call attention to unsafe conditions arising from causes other than those of natural depreciation. No reports of such imperfections need be made unless adverse conditions are discovered.

(2) At periodic intervals of from one to six months there should be inspections by bridge foremen or others experienced in bridge repairs. These inspections should be more thorough than those of the section forces, and are intended to discover all the defects arising from traffic to which the bridge is subjected, and those due to natural depreciation or other causes. Reports of such inspections should be made to the one next in authority, preferably to the one most directly or primarily responsible for the safety of the structures.

(3) Annual or semi-annual inspections are to be made by men experienced in the design and maintenance of bridges; preferably by those who are primarily responsible for their safe maintenance. The reports of these inspections should be filed, and in connection with an examination of office data, will determine the safety of the structures, and be the basis for decisions as to repairs, reinforcements or renewals.

A paper on "Review of the Development of Bridge Building in America," by C. L. Crandall, and a report on "Reinforced Concrete vs. Steel for Short-Span Bridges" were accepted.

Prof. F. E. Turneaure made a statement as to the work of the sub-committee on impact tests and read portions of the report of this sub-committee. The data, diagrams and other matter of the report are now on file in the secretary's office. Although the report is almost complete it was accepted as one of progress and the committee was directed to continue its investigations.

Wooden Bridges and Trestles.

The report on Wooden Bridges and Trestles was presented by the chairman, Prof. H. S. Jacoby. Changes in definitions proposed by the committee were adopted. In the standard specifications for southern yellow pine bridge and trestle timbers, the committee recommended changes in the titles, providing for "Standard Heart Grade," longleaf yellow pine and "Standard Grade" longleaf and shortleaf yellow pine, which were adopted.

Standard specifications for Douglas fir and western hemlock bridge and trestle timbers, submitted by the committee for the first time, are as follows:

1. Standard Heart Grade shall include yellow and red Douglas fir and western hemlock. White Douglas fir will not be accepted as standard heart grade.

2. General Requirements—All timber shall be live, sound, straight and close grained, cut square cornered, full length, not more than $\frac{1}{4}$ in. scant in any dimensions for rough timber or $\frac{1}{8}$ in. for dressed timber; free from large, loose or unsound knots, knots in groups, of other defects that will materially

impair its strength for the purpose for which it is intended. Subject to inspection before loading.

3. Stringers shall show not less than 90 per cent heart on each side and edge, measured across the surface anywhere in the length of the piece. Shall be out of wind and free from shakes, splits, or pitch pockets over $\frac{3}{8}$ in. wide or 5 ins. long. Knots greater than 2 ins. in diameter will not be permitted within one-fourth of the depth of the stringer from any corner nor upon the edge of any piece; knots shall in no case exceed 3 ins. in diameter.

4. Caps, sills and posts shall show not less than 85 per cent heart on each of the four sides, measured across the surface anywhere in the length of the piece. Shall be out of wind and free from shakes, splits, or pitch pockets over $\frac{1}{2}$ in. wide or 5 ins. long. Knots shall not exceed one-fourth of the width of the surface of the piece in which they occur and shall in no case exceed 3 ins. in diameter.

5. Longitudinal struts or girts, X braces, sash and sway braces shall show one side all heart, the other side and two edges shall show not less than 85 per cent heart, measured across the surface anywhere in the length of the piece.

6. Ties and guard timbers shall show one side and one edge all heart, the other side and edge shall show not less than 85 per cent heart, measured across the surface anywhere in the length of the piece.

7. Timbers for Howe truss chords shall show not less than 90 per cent heart on each side and edge, measured anywhere in the length of the piece. Shall be out of wind and free from shakes, splits, or pitch pockets over $\frac{3}{8}$ in. wide or 3 ins. long. Knots shall not be over $1\frac{1}{2}$ ins. in diameter nor be closer together on each surface than one in any four linear feet, but if knots are 1 in. or less in diameter, one in any three linear feet will be allowed.

8. Standard grade shall include yellow, red and white Douglas fir and western hemlock.

9. General Requirements—All timbers shall be sound and cut square cornered, except that timbers 10x10 ins. in size may have a 2 in. wane on one corner or its equivalent on two or more corners. Other sizes may have proportionate defects. Must be free from defects which will impair its utility for temporary work. Knots shall not exceed one fourth the width of the surface of the piece in which they occur. Subject to inspection before loading.

10. Stringers, caps, sills and posts shall be out of wind, free from shakes or splits extending over more than one-eighth of the length of the piece, or knots more than 4 ins. in diameter. Knots greater than 3 ins. in diameter will not be permitted on the edge of any stringer.

These specifications were adopted.

A motion to change the term "standard" grade for second quality timber was lost.

The report on piles and pile driving was received as information.

Rail.

For the committee on rail the report was presented at the evening session on Tuesday, by the chairman, Chas. S. Churchill, of the Norfolk & Western. Mr. Churchill said that the investigations of the committee, and the committee meetings had been held at the mills of various manufacturers. The specifications presented by the committee are the result of a joint meeting with a committee of the manufacturers' association, after careful consideration by both sides.

After discussion, the following conclusions were adopted:

(1) That the specifications and plan for drop testing machine, approved by the association, be revised as follows:

Paragraph 2: Eliminate the last sentence and substitute the following: "Anvil to be guided in its vertical movement by removable finished wearing strips, these wearing strips to be attached to the finished edges of the column base."

Paragraph 5: Insert the following after the word "castings" in the first sentence: "And the surface of the anvil between

BESSEMER		OPEN-HEARTH	
	70 lbs. and over, but under 85 lbs.	85 to 100 lbs. inclusive.	70 lbs. and over, but under 85 lbs.
Carbon	0.40 to 0.50	0.45 to 0.55	0.53 to 0.66
Manganese	0.80 to 1.10	0.80 to 1.10	0.70 to 1.00
Silicon	0.07 to 0.02	0.07 to 0.20	0.07 to 0.20
Phosphorus not to exceed	0.10	0.10	0.04
Sulphur not to exceed	0.075	0.075	0.06

these pedestals shall be formed to receive a wooden block to absorb shock under broken test pieces."

Paragraph 6: In the first sentence substitute the words "column base" for "base plate."

(2) That the specifications and plan for drop testing machine, as revised above, be printed in the Manual of Recommended Practice.

(3) That the present specifications for steel rails be withdrawn from the Manual of Recommended Practice of the association as no longer representing the present state of the art.

(4) That the specifications for bessemer and open-hearth rails, as recommended, be printed in the proceedings, and that a note be added to the effect that these specifications are intended for a guide in the preparation of future specifications, and it is recommended that all railroads embody in their specifications such matter from the specifications herewith presented as in their judgment is necessary to secure better results from the mills.

(5) That rail failure statistics be collected for tabulation and analysis from railroad companies for the period of one year ending October 31, instead of for a period of six months, as recommended in the Proceedings, A. R. E. and M. W. Assn., Vol. 10, Part 1, page 375, Conclusion No. 2, and that the title of form M. W. 2004-A, Proceedings, Vol. 10, Part 1, page 355, be changed to read "Summary of Steel Rail Failures for One Year, Compared with the same Period of Previous Year," with corresponding change in the footnote of the same form.

Specifications for Steel Rails.

1. The entire process of manufacture shall be in accordance with the best current state of the art.

(a) Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify.

(b) Bleed ingots shall not be used.

2. The chemical composition of the steel from which the rails are rolled shall be within the following limits:

3. When the average phosphorus content of the ingot metal used in the Bessemer process at any mill is below 0.08 and in the Open-Hearth process is below 0.03, the carbon shall be increased at the rate of 0.035 for each 0.01 that the phosphorus content of the ingot metal used averages below 0.08 for Bessemer steel, or 0.03 for Open-Hearth steel. The percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits.

4. The end of the bloom formed from the top of the ingot shall be sheared until the entire face shows sound metal. All metal from the top of the ingot, whether made from the bloom or the rail, is the top discard.

5. The number of passes and speed of train shall be so regulated that, on leaving the rolls at the final pass, the temperature of the rails will not exceed that which requires a shrinkage allowance at the hot saws, for a 33-ft. rail of 100 lbs. section, of $6\frac{1}{2}$ ins. for thick base sections and $6\frac{3}{4}$ ins. for A. S. C. E. sections, and $\frac{1}{8}$ in. less for each 10 lbs. decrease of section, these allowances to be decreased at the rate of 1-100 in. for each second of time elapsed between the rail leaving the finishing rolls and being sawed.

The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used between the leading and finishing passes, nor after they leave the finishing pass.

6. The section of rail shall conform as accurately as possible to the template furnished by the railroad company. A

variation in height of 1-64 in. less or 1-32 in. greater than the specified height, and 1-16 in. in width of flange, will be permitted; but no variations shall be allowed in the dimensions affecting the fit of splice bars.

7. The weight of the rail shall be maintained as nearly as possible, after complying with the preceding paragraph, to the specified in the contract. A variation of one-half of one per cent from the calculated weight of section, as applied to an entire order, will be allowed.

Rails will be accepted and paid for according to actual weight.

8. The standard length of rail shall be 33 ft. Ten per cent of the entire order will be accepted in shorter lengths varying by 1 ft. from 32 ft. to 25 ft. A variation of $\frac{1}{4}$ in. from the specified lengths will be allowed. All No. 1 rails less than 3 ft. shall be painted green on both ends.

9. Care shall be taken in hot-straightening rails, and it shall result in their being left in such condition that they will not vary throughout their entire length more than 4 in. from a straight line in any direction for thick base sections, and 5 in. for A. S. C. E. sections when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so marked.

The distance between supports of rails in the straightening press shall not be less than 42 ins.; supports to have flat surfaces and out of wind. Rails shall be straight in line and surface and smooth on head when finished, final straightening being done while cold.

They shall be sawed square at ends, variations to be not more than 1-32 in., and prior to shipment shall have the burr caused by the saw cutting removed and the ends made clean.

10. Circular holes for joint holes shall be drilled in accordance with specifications of the purchaser. They shall in every respect conform accurately to drawing and dimensions furnished and shall be free from burrs.

11. The name of the manufacturer, the weight of the rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web. The number of the heat and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail, where it will not be covered by the splice bars. Rails to be lettered consecutively A, B, C, etc., the rail from the top of the ingot being A. In case of a top discard of 20 or more per cent the letter A will be omitted. Open-Hearth rails to be branded or stamped O H. All marking of rails shall be done so effectively that the marks may be read as long as the rails are in service.

12. (a) Drop tests shall be made on pieces of rail rolled from the top of the ingot, not less than 4 ft. and not more than 6 ft. long, from each heat of steel. These test pieces shall be cut from the rail bar next to either end of the top rail, as selected by the inspector.

The temperature of the test pieces shall be between 40 and 100 degs. Fahr.

The test pieces shall be placed head upward on solid supports, 5 in. top radius, 3 ft. between centers, and subjected to impact tests, the top falling free from the following heights:

70-lb. rail	16 ft.
80, 85 and 90-lb. rail.....	18 ft.
100-lb. rail	20 ft.

The test pieces which do not break under the first drop shall be nicked and tested to destruction.

(b) (It is proposed to prescribe, under this paragraph, the

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requirements in regard to deflection, fixing maximum and minimum limits, as soon as proper deflection limits have been decided upon.)

13. (A) Two pieces shall be tested from each heat of steel. If either of these test pieces break, a third piece shall be tested. If two of the test pieces break without showing physical defects, all rails of the heat will be rejected absolutely. If two of the test pieces do not break, all rails of the heat will be accepted as No. 1 or No. 2 classification (according as the deflection is less or more, respectively, than the prescribed limit.*)

(B) If, however, any test piece broken under test A shows physical defect, the top rail from each ingot of that heat shall be rejected.

(C) Additional tests shall then be made of test pieces selected by the inspector from the top end of any second rails of the same heat. If two out of three of these second test pieces break, the remainder of the rails of the heat will also be rejected. If two out of three of these second test pieces do not break, the remainder of the rails of the heat will be accepted, provided they conform to the other requirements of these specifications, as No. 1 or No. 2 classification (according as the deflection is less or more, respectively, than the prescribed limit.*)

(D) If any test piece, test A, does not break, but when nicked and tested to destruction shows interior defects, the top rails from each ingot of that heat shall be rejected.

14. The drop-testing machinery shall be the standard of the American Railway Engineering and Maintenance of Way Association, and have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of 5 ins.

The anvil block shall be adequately supported and shall weigh 20,000 lbs. The supports shall be a part of or firmly secured to the anvil.

15. No. 1 rails shall be free from injurious defects and flaws of all kinds.

16. Rails which, by reason of surface imperfections, are not accepted as No. 1 rails, will be classed as No. 2 rails, but rails containing physical defects which impair their strength, shall be rejected.

No. 2 rails to the extent of 5 per cent of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white, and shall have two prick punch marks on the side of the web near the heat number near the end of the rail, so placed as not to be covered by the splice bars.

Rails improperly drilled, straightened, or from which the burrs have not been properly removed, shall be rejected, but may be accepted after being properly finished.

Different classes of rails shall be kept separate in shipment.

All rails shall be loaded in the presence of the inspector.

17. (a) Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made in accordance with the terms of the specifications.

(b) For Bessemer steel the manufacturer shall, before the rails are shipped, furnish the inspector daily with carbon determinations for each heat, and two complete chemical analyses every 24 hours representing the average of the other elements specified in section 2 hereof contained in the steel, for each day and night turn respectively. These analyses shall be made on drilling taken from the ladle test ingot not less than $\frac{1}{4}$ in. beneath the surface.

For Open-Hearth steel, the makers shall furnish the inspectors with a complete chemical analysis of the elements specified in section 2 hereof for each melt.

(c) On request of the inspector, the manufacturer shall furnish drillings from the test ingot for check analysis.

(d) All tests and inspections shall be made at the place

*Note: The clause in brackets in sections A and C to be added to the specifications when the deflection limits are specified.

TABLE NO. I.

AVERAGE HOURLY EVAPORATION FOR 2000 FT. O. HEATING SURFACE.
FOR VARIOUS RATIOS OF HEATING SURFACE TO GATE AREA
AND FOR VARIOUS RATES OF FUEL CONSUMPTION BASED ON
USE OF BITUMINOUS COAL TESTING 15000 BTU. PER POUND.

RATIO	LBS. COAL PER SQ. FT. GATE AREA PER HOUR										
	60	70	80	90	100	110	120	130	140	150	
R-50	8136	8905	9690	10324	10879	11365	11790	12162	12457	12771	5020
R-55	7497	8480	9165	9764	10282	10747	11149	11501	11840	12019	12214
R-60	7293	8057	8676	9254	9751	10185	10567	10900	11191	11445	11669
R-65	6913	7617	8233	8772	9244	9657	10015	10334	10610	10851	11084
R-70	6566	7234	7818	8329	8776	9167	9509	9888	10070	10299	10500
R-75	6258	6874	7430	7917	8343	8710	9042	9327	9576	9794	9985
R-80	5959	6541	7070	7532	7936	8289	8595	8868	9104	9311	9492
R-85	5677	6253	6761	7204	7591	7930	8227	8487	8714	8912	9085
R-90	5440	5993	6477	6900	7270	7594	7878	8126	8343	8533	8699
R-95	5211	5741	6205	6611	6958	7277	7549	7817	7995	8177	8336

ABOVE TABLE ASSUMES FEED WATER AT AVERAGE OF 60° F. AND BOILER PRESSURE 200 LBS.
FOR 100 FT. DIA. BOILER PRESSURE APPROXIMATELY ONE HALF PER CENT GREATER QUANTITY WOULD
BE EXHAUSTED.

FOR COAL OF DIFFERENT THERMAL VALUE THAN 15000 BTU.
MULTIPLY TABULAR QUANTITIES BY FOLLOWING DECIMALS:

14900 BTU. - .967	15000 BTU. - .80
14000 - - .933	15000 - - .767
13300 - - .900	15000 - - .733
13000 - - .887	15000 - - .70
12500 - - .859	15000 - - .667

of manufacture prior to shipment, and shall be so conducted as not to unnecessarily interfere with the operation of the mill.

In discussing specification 2, Mr. G. J. Ray, chief engineer of the Lackawanna, said that the chemical composition should refer to an analysis of the rail rather than of the ingot, which may not be exactly like the composition of the rail. Mr. J. O. Osgood also said that he had observed the difference in composition as between the steel of the ingot and of the finished rail. He inquired why the carbon in open-hearth rails had been held down to a maximum of 0.76 per cent. Mr. Churchill explained that Specification No. 3 provided for increase of the

TABLE NO. II

WEIGHT OF STEAM USED IN ONE REVOLUTION OF CYLINDER
IN LOCOMOTIVE CYLINDERS.

CYLINDER DIAMETER IS FOR HIGH PRESSURE CYLINDERS IN COMPOUND LOCOMOTIVES.

DIAMETER IN INCHES	WEIGHT OF STEAM USED IN ONE REV. IN FEET	WEIGHT OF STEAM USED IN ONE REV. IN FEET FOR CYLINDERS OF VARIOUS DIAMETERS				
		220 "	210 "	200 "	190 "	180 "
12	0.4146	0.7046	0.570	0.515	0.457	0.401
13	0.475	0.456	0.445	0.415	0.396	0.357
14	0.521	0.529	0.504	0.482	0.459	0.436
15	0.623	0.607	0.576	0.552	0.51	0.476
15½	0.675	0.649	0.618	0.590	0.562	0.535
16	0.71	0.691	0.658	0.629	0.59	0.553
17	0.718	0.730	0.745	0.710	0.676	0.645
18	0.711	0.785	0.854	0.796	0.759	0.722
18½	0.692	0.921	0.851	0.751	0.801	0.724
19	1.015	0.975	0.928	0.887	0.845	0.803
19½	1.089	1.027	0.978	0.934	0.89	0.847
20	1.125	1.080	1.029	0.985	0.936	0.891
20½	1.181	1.134	1.081	1.032	0.984	0.936
21	1.240	1.191	1.154	1.083	1.037	0.982
22	1.361	1.307	1.249	1.189	1.135	1.078
23	1.487	1.428	1.361	1.300	1.238	1.178
28	2.704	2.117	2.017	1.928	1.835	1.745

FOR WEIGHT OF STEAM USED PER REVOLUTION OF CYLINDERS AT FULL CUT-OFF.
MULTIPLY THE TABULAR QUANTITY BY FOUR TIMES THE LENGTH OF STROKE IN
FEET FOR SIMPLE AND FOUR CYLINDER COMPOUNDS. FOR TWO CYLINDER COM-
POUNDS MULTIPLY BY TWO TIMES THE LENGTH OF STROKE.

RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

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TABLE No. 3.
Values of coefficient "C" for changing revolutions per minute of drivers into velocity in miles per hour

336.13

Diam.	"C"		Diam.	"C"		Diam.	"C"	
	Diameter of drivers in inches	Revolutions per minute		Miles per hour =	"C"		Miles per hour =	"C"
50 in	6.72	58 in	5.79	66 in.	5.09	74 in.	4.54	
51 "	6.50	59 "	5.60	67 "	5.01	75 "	4.48	
52 "	6.46	60 "	5.60	68 "	4.94	76 "	4.42	
53 "	6.34	61 "	5.51	69 "	4.87	77 "	4.36	
54 "	6.22	62 "	5.42	70 "	4.80	78 "	4.31	
55 "	6.11	63 "	5.33	71 "	4.73	79 "	4.25	
56 "	6.00	64 "	5.25	72 "	4.67	80 "	4.20	
57 "	5.89	65 "	5.17	73 "	4.60	81 "	4.15	

TABLE No. 4.
MAXIMUM CUT-OFF AND POUNDS OF STEAM
PER I.H.P. HOUR
FOR VARIOUS MULTIPLES OF "M".

*M = MAXIMUM VELOCITY IN MILES PER HOUR AT FULL CUT-OFF. BOILER PRESSURE, 200 LBS.

VELOCITY CUT-OFF	LBS. STEAM PER I.H.P. HOUR		VELOCITY CUT-OFF	LBS. STEAM PER I.H.P. HOUR	
	SIMPLE LOC.	COMPOUND LOC.		SIMPLE LOC.	COMPOUND LOC.
1.0 M ¹	58.30	25.80	29.84 ²	38.5	24.37
1.1	54.46	24.36	3.0	37.0	24.72
1.2	50.91	24.24	52	34.2	24.00
1.3	48.43	23.56	22.35	34	23.85
1.4	47.07	52.41	21.65	36	23.58
1.5	46.77	51.40	21.14	38	23.38
1.6	46.4	50.49	20.77	40	23.2
1.7	46.07	29.67	20.52	42.5	23.05
1.8	45.73	28.93	20.40	43.0	23.0
1.9	45.4	28.25	20.40	47.5	22.9
2.0	45.1	27.62	20.40	5.0	22.8
2.1	44.8	27.05	20.40	5.5	22.7
2.2	44.5	26.52	20.40	6.0	22.6
2.3	44.2	26.06	20.40	6.5	22.5
2.4	43.9	25.67	20.40	7.0	22.4
2.5	43.7	25.32	20.47	7.5	22.3
2.6	43.5	25.02	20.60	8.0	22.2
2.7	43.3	24.76	20.75	9.0	22.1
2.8	43.1	24.54	20.85		

FOR STEAM PER I.H.P. HOUR AND OTHER Boiler Pressures TAKE THE FOLLOWING
PERCENTAGES OF VALUES GIVEN IN TABLE:

180 Lbs. = 103% 190 Lbs. = 106%
170 Lbs. = 102.5% 210 Lbs. = 99.5%
160 Lbs. = 101.5% 230 Lbs. = 99.5%

TABLE No. 5.
PERCENT CYLINDER TRACTIVE POWER
FOR
VARIOUS MULTIPLES OF "M".

*M = MAXIMUM VELOCITY IN MILES PER HOUR AT WHICH BOILER PRESSURE
CAN BE MAINTAINED WITH FULL CUT-OFF

VELOCITY	COMPOUND %		VELOCITY	COMPOUND %		VELOCITY	COMPOUND %	
	SIMPLE %	VELOCITY		SIMPLE %	VELOCITY		SIMPLE %	VELOCITY
START	52.40	100.00	3.6 M	52.40	44.75	6.4 M	23.50	
0.5 M	10.88	103.00	37	31.25	43.96	63		23.16
1.0	-100.00	100.00	58	50.10	42.50	65		22.79
1.1	96.18	95.57	59	28.16	41.24	67		22.42
1.2	92.55	91.53	46	28.24	40.10	68		22.08
1.3	88.85	87.83	41	27.58	39.00	69		21.71
1.4	85.12	84.46	41	26.56	37.06	70		21.38
1.5	81.40	81.37	43	25.77	36.97	71		21.06
1.6	77.68	78.55	44	25.05	36.03	72		20.75
1.7	73.96	75.97	45	24.34	35.15	73		20.45
1.8	70.25	73.60	46	23.69	34.26	74		20.16
1.9	66.54	71.41	47	23.07	33.41	75		19.88
2.0	63.21	69.37	48	22.48	32.59	76		19.61
2.1	60.20	67.47	49	21.92	31.82	77		19.34
2.2	57.48	65.67	50	21.38	31.11	78		19.08
2.3	54.97	63.64	51	20.87	30.42	79		18.82
2.4	52.66	61.22	52	20.37	29.75	80		18.57
2.5	50.45	60.55	53	19.89	29.10	81		18.33
2.6	48.36	58.92	54	19.45	28.48	82		18.09
2.7	46.08	57.53	55	18.99	27.87	83		17.86
2.8	44.10	55.78	56	17.33	64			17.64
2.9	42.16	54.16	57	26.81	65			17.43
3.0	40.57	51.78	58	26.50	66			17.22
3.1	38.95	51.55	59	25.81	67			17.01
3.2	37.42	49.91	60	25.34	68			16.82
3.3	35.98	48.55	61	24.88	69			16.65
3.4	34.66	47.14	62	24.44	70			16.45
3.5	33.35	45.07	63	24.01				

TABLE No. 6.
POUNDS TRACTIVE POWER FOR ONE HORSE POWER
AT
VARIOUS SPEEDS
Formula: 1 H.P. = $\frac{333}{Velocity}$ in Miles per Hour

VELOCITY	POUNDS TRACTIVE POWER FOR ONE HORSE POWER								
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
3	185.0	120.07	117.10	115.64	110.89	107.14	104.17	101.55	98.68
4	93.5	61.46	59.29	57.21	53.73	53.55	51.82	50.97	50.15
5	75.00	73.53	72.12	70.75	69.44	68.18	66.98	65.79	64.66
6	62.50	61.86	60.48	59.32	58.59	57.69	56.82	55.97	55.15
7	53.57	52.85	51.08	50.68	50.00	49.34	48.70	48.08	47.47
8	46.86	46.50	45.74	45.18	44.64	44.12	43.60	43.10	42.61
9	41.47	41.21	40.78	40.35	39.89	39.06	38.66	38.27	37.88
10	37.59	37.13	36.77	36.41	35.71	35.38	35.05	34.72	34.40
11	34.09	33.78	33.48	33.19	32.89	32.61	32.33	32.05	31.78
12	31.25	30.99	30.74	30.49	30.24	29.96	29.53	29.30	29.07
13	28.85	28.63	28.41	28.20	27.99	27.78	27.57	27.37	27.17
14	26.79	26.60	26.41	26.22	26.04	25.86	25.68	25.51	25.37
15	25.00	24.85	24.67	24.51	24.39	24.19	24.04	23.88	23.58
16	23.44	23.26	23.15	23.01	22.87	22.75	22.69	22.64	22.58
17	21.66	21.51	21.39	21.25	21.11	21.01	20.91	20.81	20.71
18	20.83	20.72	20.60	20.49	20.38	20.27	20.16	20.05	19.94
19	19.74	19.63	19.53	19.43	19.33	19.23	19.13	19.03	18.94
20	18.75	18.66	18.56	18.47	18.38	18.29	18.20	18.12	17.94
21	17.86	17.77	17.69	17.61	17.52	17.44	17.36	17.28	17.12
22	17.05	16.97	16.89	16.82	16.74	16.67	16.59	16.52	16.37
23	16.36	16.23	16.16	16.09	16.03	15.96	15.89	15.82	15.69
24	15.65	15.56	15.50	15.43	15.37	15.31	15.24	15.18	15.06
25	15.00	14.94	14.88	14.81	14.76	14.71	14.65	14.59	14.48
26	14.42	14.37	14.31	14.26	14.20	14.15	14.10	14.04	13.94
27	13.89	13.84	13.79	13.74	13.68	13.63	13.59	13.54	13.44
28	13.36	13.35	13.30	13.28	13.25	13.21	13.16	13.12	13.02
29	12.93	12.89	12.84	12.80	12.76	12.71	12.67	12.63	12.54
30	12.50	12.46	12.42	12.38	12.34	12.30	12.26	12.22	12.14
31	12.10	12.06	11.98	11.94	11.90	11.87	11.83	11.79	11.76
32	11.72	11.66	11.61	11.57	11.54	11.50	11.47	11.43	11.40
33	11.30	11.33	11.30	11.26	11.23	11.19	11.16	11.13	11.06
34	10.85	11.00	10.95	10.90	10.87	10.84	10.81	10.78	10.74
35	10.71	10.68	10.65	10.59	10.56	10.53	10.50	10.47	10.44
36	10.42	10.39	10.36	10.30	10.27	10.24	10.21	10.18	10.16

For intermediate velocities, values per horse power can be found by interpolation.

TABLE No. 7.
LOCOMOTIVE RESISTANCES

(A)	CYLINDER TO END OF DRIVERS.						
	TOTAL POUNDS R = 18.77 + 80N	N = NUMBER OF DRIVERS					
(B)	ENGINE AND TENDER TRUCKS						
	TOTAL POUNDS R = 1.07 + 2.0N	N = NUMBER OF TRUCK AXLES					
(C)	HEAD END OR AIR RESISTANCE						
	R = 0.007V ²	V = VELOCITY IN MILES PER HOUR					
	A = AREA (AVERAGE PER LOCOMOTIVE - 123.50 ft ²)	RUNNING SPEEDS					
	TOTAL R = 0.23V ²						
AIR RESISTANCE (C) FOR VARIOUS VELOCITIES							
VELOCITY	R	VELOCITY	R	VELOCITY	R	VELOCITY	R
1	0.23	11	30	21	110	31	240
2	1.00	12	36	22	121	32	256
3	2.25	13	42	23	132	33	272
4	4.00	14	49	24	144	34	289
5	6.25	15	56	25	156	35	306
6	9.00	16	64	26	169	36	324
7	12.25	17	72	27	182	37	342
8	16.00	18	81	28	196	38	361
9	20.25	19	90	29	210	39	380
10	25.00	20	100	30	225	40	400

carbon where the phosphorus falls below the 0.04 per cent maximum.

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too hard or too soft. He thinks that drop tests carefully specified and adhered to are a good check upon the chemical composition. After discussion the specification was adopted.

After the disposal of the report of the rail committee, Mr. J. W. Kendrick, first vice-president of the Atchison, Topeka & Santa Fe Ry., delivered a lecture on conservation of ties. The lecture was illustrated by lantern slides. The plan adopted by the Santa Fe road, for experiment, is the use of screw spikes and dowel plugs. Much interesting data bearing on the timber supply of the country was brought out.

Economics of Railway Location.

The report of the Committee on Economics of Railway Location was presented by the chairman, Mr. A. K. Shurtleff, of the Rock Island. In discussion, Mr. L. C. Fritch, chief engineer of the Chicago Great Western, said it was his opinion, that railroads are wasting a good deal of power in not taking into account the relation of locomotive capacity to the grades. In some cases, also, he thought that some roads were reducing grades unnecessarily—the use of heavier power might accomplish practically all that is desired in tonnage rating.

The conclusions of the committee are as follows:

(1) Actual drawbar pull of the locomotive at various speeds should be used in making estimates with reference to economic value of various locations of line and grade, where such drawbar pull is known. Where not known, the drawbar pull should be calculated. In comparing a new line with an existing line the same percentage of efficiency of drawbar pull should be used in both cases.

(2) The tractive power of a locomotive depends on its steam-producing capacity, the boiler pressure, the adhesion, and the size of the cylinders and drivers.

(3) The steam-producing capacity of a locomotive depends mainly upon the quantity and quality of the fuel burned, and the area of heating surface.

(4) Knowing the area of heating surface, the average steam production of locomotives burning bituminous and similar coals can be estimated by the use of Table No. 1, assuming 4,000 lbs. of coal as the maximum quality that can be properly "fired" per hour.

(5) The maximum velocity at which full cut-off can be maintained can be found by dividing the pounds of steam produced per minute by the quantity of steam used per revolution of the drivers, as shown in Table No. 2. Dividing this quotient by the coefficient given in Table No. 3 for the diameter of the drivers will give the speed in miles per hour at which full cut-off can be maintained. This velocity is referred to as "M" in the tables.

(6) Tractive power of a locomotive is greatest at starting, gradually reducing to the maximum velocity ("M") at which full cut-off can be maintained. At speeds above this velocity the tractive power decreases more rapidly. The tractive power at any multiple of "M" is practically a fixed percentage of the tractive power at "M." The fixed percentages are different for compound types than for simple locomotives.

(7) Knowing the steam production of a locomotive and the maximum velocity at which full cut-off can be maintained ("M"), the indicated horse-power of the locomotive can be obtained for velocity "M" or higher velocities by dividing the total steam produced per hour by the quantity of steam used per I. H. P. hour, as given in Table No. 4, after applying the corrections for proper boiler pressure.

(8) Horse-power can be converted into tractive power by the formula, tractive power equals 375 times the HP., divided by the velocity in miles per hour. To simplify the operation, the tractive power can be obtained by multiplying the H. P. by the figures shown in Table No. 6.

(9) Where I. H. P. at "M" velocity has been converted into cylinder tractive power, the cylinder tractive power at other multiples of "M" can be determined by using the percentages

given in Table No. 5 without first calculating the I. H. P. for the respective multiples of M.

(10) Available drawbar pull on level tangent is the cylinder tractive power less the sum of the resistances from the cylinder to the rim of drivers, the resistance through the trucks of engine and tender, and the "head end" or velocity resistance. The formulas and data given in Table No. 7 are recommended for use in determining these resistances. Available drawbar pull at starting, with use of sand, should not usually be considered as greater than 30 per cent of the weight on locomotive drivers and at running speeds not greater than 25 per cent.

(1) Dynamometer tests to be of the greatest value should show the following:

(a) Dynamometer record (graphical) showing drawbar pull to nearest ten pounds, with horizontal scale not less than 400 ft. to one inch and in special cases a larger scale.

(b) Speed record to nearest tenth of mile per hour (graphical).

(c) Key to record mile posts.

(d) Condition of track surface (graphical) and gage.

(e) Steam pressure of boiler (graphical).

(f) Train line air pressure (graphical).

(g) Time record (graphical).

(Speed record may be independent record, and in this case time record is desirable.)

(h) Coal consumption (record of shovels of coal as used) (worked by hand in engine).

Requisite data to be taken.

Track.

(i) Office profile and alignment connecting with mile posts (so as to connect with 3).

(j) Section of rail.

(k) Condition of rail.

(l) Number of ties to rail (and rail length).

(m) Kind and quantity of ballast.

Locomotive.

(n) Type (wheel arrangement, whether simple or compound and dimensions of locomotive).

(o) Total weight and weight on drivers.

Cars.

(p) Record of length, initial, number, class of each car of train, also weight empty and weight loaded.

(q) Kind of truck.

(r) Condition of car.

Weather.

(s) Temperature.

(t) Direction and force of wind and direction of train.

(u) State of weather (rain or clear).

(2) Resistance of freight trains shows practically no change of resistance between seven and thirty-five miles per hour.

(3) It is recommended that for freight train resistances between seven and thirty-five miles per hour the formula,

$$R=2.2T+121.6C,$$

be used for comparing freight train ratings on different lines and grades.

R = total resistance on level tangent.

T = total weight cars and contents in tons.

C = total number of cars.

(4) In order to equalize resistance on curve and tangent, curves shall ordinarily be compensated .035 per cent per degree of curvature. Effect of curve resistance is dispelled more slowly at slow speed than at high speed.

(5) Superelevation and depression should be equally divided between high and low rail of curve, in order to avoid shock in entering curve and exceeding maximum gradient on the run-off of curves. This recommendation was stricken out by vote.

(6) Condition of roadway maintenance has a great effect on train resistance.

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(7) Condition of equipment has a great effect on train resistance.

(8) Train resistance is greater in cold weather than in warm. Per cent of rating on account of variation in temperature, as shown in body of report, is recommended for use in making comparisons of new lines and not for tonnage rating.

(9) Resistance of individual cars of same weight but of different type shows considerable variation. Sufficient data are not yet available to determine just how much the difference is.

(10) Starting resistance varies from 10 to 40 lbs. per ton, depending on loading, temperature and character of maintenance of roadway and equipment.

(1) A straight line is the best alignment.

(2) The justifiable expenditure to eliminate one degree of central angle in the alignment of roadway depends largely on the number of daily trains and the cost per train mile.

(3) As a general rule it is good practice to spend more money to take out one degree of central angle where the radius is small, requiring the maximum elevation of outer rail, than where the radius is large, requiring less elevation.

(4) As a general rule, it is justifiable to spend more money to take out one degree of central angle where trains run at a high rate of speed than where the speed is low.

Discussing Conclusion 10, Prof. W. D. Pence wished to know why the committee had increased to 30 and 25, respectively, the percentages of drawbar pull to weight on locomotive drivers. Mr. Shurtleff replied that these figures might be considered as the maximum obtainable in any section of the country. Personally, he had observed 33 per cent with the use of sand. Mr. Churchill said he had been using 22½ per cent in place of the committee's 25 per cent, as a safe figure.

There was considerable discussion on the consideration of the rate of compensation of grades for curvature. Mr. Fritch thought that .035 per cent was too low to cover all conditions, and he moved to make it .04 per cent. Several gentlemen, including Mr. C. E. Lindsay, called attention to the influence of curve elevation on curve resistance, the resistance increasing with the elevation in the outer rail. The discussion resulted in the acceptance of the paragraph (4) with the insertion of the word "ordinarily," thus fixing the rate of compensation at .035 for average conditions.

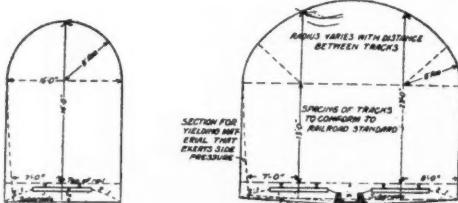
The committee had recommended dividing curve elevation between the two rails, by raising the outer rail half of the specified elevation and depressing the inner rail the other half, so as not to increase the grade of the track as a whole. Mr. Lindsay asked if any man present had succeeded in maintaining track in that way. Mr. D. W. Lum, of the Southern Ry.; Mr. H. T. Porter, of the Bessemer & Lake Erie R. R.; Mr. W. M. Camp and others spoke of the difficulty of maintaining curve elevation unless one of the rails be maintained on the "straight grade." The result was a vote to strike out the recommendation.

WOOD PRESERVATION

The report on wood preservation was presented by the chairman of the committee, Mr. W. K. Hatt. The specifications for zinc-chloride, zinc-tannin and creosote treatments were submitted with slight changes in language as printed in the Manual.

The following additions were presented as "recommended practice" for printing in the Manual:

(7) All chemicals used should be tested for purity from time to time. Either the chemists for the company will do this



themselves or indicate some simple tests which may be applied by operatives at the works.

(8) In operating with zinc-chloride, the strength of the solution should be varied from time to time to conform to the kind and condition of the ties, so as to inject required quantities. But in no case shall the strength of the solution exceed 5.0 per cent.

(9) It is better to inject quantities of the chemicals in excess of the requirements than to skimp the treatment in any way.

(10) Daily reports should be kept at the works, and duplicates sent to the general office if desired, in order to check the operations.

(11) Ties treated with zinc-chloride should dry for some little time (to harden the outer surface) before they are put in the tracks. This is preferably done in piles, arranged to induce drying without checking as evaporation takes place.

(12) Dating nails should be inserted in the ties and an account kept of the average life obtained, in order to be able hereafter to improve on the treatment.

(13) In order to observe the penetration of the oil, holes should be bored with a 3/4-in. auger, in not less than three ties in each cylinder load. The holes should be plugged with plugs 1-16 in. larger than the hole.

TIES.

The report of the committee on ties was introduced by the vice-chairman of the committee, Mr. E. E. Hart, chief engineer of the New York, Chicago & St. Louis. The following changes in the way of revision of the manual, were recommended:

DEFINITIONS.

Tie—The transverse member of a railway track supporting the rails by means of which they are retained in position.

Pole Tie—A tie made from a tree of such size that not more than one tie can be made from a section; a pole tie generally shows sapwood on two sides.

Sap Tie—A tie which shows more than the prescribed amount of sapwood in cross-section.

Score Mark—A mark made by the ax as a guide in hewing

SPECIFICATIONS FOR DATING NAIL.

The committee recommends that the first and second paragraphs be as follows:

"1. The nail shall be made of iron or steel, galvanized with a coating of zinc, evenly and uniformly applied, so that it will adhere firmly to the surface of the steel; it shall be 1/4 in. in diameter, 2 1/2 in. in length, with head 5/8 in. in diameter, having stamped therein two figures designating the year; the figures to be 3/8 in. in length and depressed into the head 1-16 in.

"2. Any specimen shall be capable of withstanding the following test: The sample shall be immersed in a standard solution of copper sulphate of one minute and then removed immediately and thoroughly washed in water and wiped dry; this process shall be repeated four times if necessary and if after any immersion there is a copper-colored deposit on the sample, or the zinc has been removed, the lot from which the sample was taken shall be rejected."

FORMS AND RULES FOR TIE RECORDS.

The committee recommends that the first paragraph under this heading be withdrawn, and that the third paragraph be made to read as follows:

"A dating nail should be driven in the upper side of every treated tie 10 in. inside of the rail, and on the line side of the track. The tie should be laid with the end having the year stamped on it on the line side of the track. Dating nails should be driven the same day the tie is put in.

"Section foremen should be especially careful to see that the marks or nails intended to identify the ties are not injured or destroyed.

"It is recommended that, in addition to the use of dating nail, each tie be stamped with the year at the treating plant, before treatment, and, preferably, be stamped on both ends."

SPECIFICATIONS FOR TIE TREATMENT; SPECIFICATIONS FOR THE

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ANALYSIS OF COAL-TAR CREOSOTE; DETERMINATION OF ZINC IN TREATED TIMBERS.

"The committee recommends that the matter under the above headings now incorporated in the Manual of Recommended Practice be withdrawn. The committee understands that this subject is being considered by the committee on wood preservation.

The following conclusions of the committee were adopted:

(1) Your committee recommends the approval of the changes proposed in the Manual of Recommended Practice.

(2) Your committee has recommended and the association has adopted a series of rules and blank forms for establishing a record of ties, and your committee regrets that the blank forms have not been generally adopted by the railroad companies. After further careful study of the subject, your committee cannot recommend any change in the rules or blank forms, but again recommends their general adoption and use by railroad companies.

It having been found impossible to obtain replies to the numerous questions embraced in the forms adopted, the practice of issuing them will be discontinued, and an endeavor will be made to obtain in other ways information which will be of value to the association.

(3) Your committee concludes that the cultivation of trees as a basis of future tie supply should be undertaken where practicable.

The discussion developed the fact that a good deal of difficulty is being had in getting the track forces to co-operate in keeping accurate statistics of the life of ties. Mr. E. O. Faulkner, superintendent of the tie and timber department of the Santa Fe, said that his road uses round-headed and square-headed dating nails to distinguish between treated and untreated ties. Generally, it is found that the 1,400 section foremen do not exercise the care necessary to preserve information in an intelligent and systematic manner. In consideration of such expectations his road has set apart two or three sections on each district of the road, under foremen of more than ordinary ability and intelligence, so that there are only comparatively few sections to watch, and in this matter the statistics obtained are more reliable than would otherwise be the case.

BALLAST.

Mr. John V. Hanna, chief engineer of the Kansas City Terminal Ry., chairman of the committee on ballast, presented the report of the committee. The following specifications were submitted and adopted:

1. Stone ballast shall be sufficiently durable not to disintegrate in the climate where used; hard enough to prevent pulverizing unduly under the action of tools or traffic, and shall break with an angular fracture when crushed.

2. The maximum size shall not exceed pieces which will pass through a $2\frac{1}{2}$ -in. test ring in any direction.

The minimum size shall not pass through a $\frac{3}{4}$ -in. test ring, and the rock shall be free from dust, dirt or rubbish.

For Class A Roads: When bank gravel contains more than 2 per cent of dust or 40 per cent of sand, it should be washed or screened. Washed or screened gravel should contain not less than 25 per cent nor more than 35 per cent of sand.

For Class B Roads: When bank gravel contains more than 3 per cent of dust or 60 per cent of sand, it should be screened or washed. Screened or washed gravel should contain not less than 25 per cent nor more than 50 per cent of sand.

For Class C Roads: Any material which makes better track than the natural roadbed may be economically used.

A recommendation as to physical tests of stone given by the United States government (Form 28, U. S. Dept. of Agriculture), was adopted.

The following recommendation as to methods of cleaning foul ballast were submitted and adopted:

Under usual conditions no ballast except stone or hard slag, be cleaned.

CLEANING FOUL BALLAST, RECOMMENDED PRACTICE.

Clean with ballast forks.

Clean shoulder down to subgrade.

Clean between ties to bottom of ties.

Clean center ditch of double track to subgrade.

Return clean ballast.

Stone ballast should be cleaned in terminals at intervals of 1 to 3 years.

On heavy traffic, coal and coke lines, at intervals of 3 to 5 years.

On light traffic lines, at intervals of 5 to 8 years.

Per cent of new stone ballast to be applied: 12 to 25 per cent.

A proposition by one of the members to clean stone ballast between the ties, to a depth of 5 ins. below the bottom of the ties, did not meet with favor.

TRACK.

The report of the committee on track was introduced by Chairman Mr. L. S. Rose, of the Big Four.

The committee recommended substituting the following for that portion of page 64 in the Manual of Recommended Practice under "Maintenance of Gage."

(1) Tie plates should be applied in all cases where greater economy in maintenance is secured by their use than in depending on the life of the tie limited by rail wear.

(2) Shoulder tie plates are recommended in preference to rail braces, except for guard rails and stock rails at switches, where the latter should be used.

(3) For heavy traffic, shoulder tie plates should be used on all ties on curves.

(4) For medium traffic, shoulder tie plates should be used on all ties on curves over three degrees.

(5) For light traffic, the outside of rails on curves should be double spiked.

(6) The gage (tool) used should be the standard gage recommended.

(7) When track is intended to be spiked to standard gage, the rail should be held against the gage with a bar while the spike is being driven.

(8) Within proper limits, a slight variation of gage from the standard is not seriously objectionable, provided the variation is uniform and constant over long distances. Under ordinary conditions it is not necessary to regage track if the increase in gage has not amounted to more than one-half inch, providing such increase is uniform.

(9) Spikes should be started vertically and square, and so driven that the face of the spike shall come in contact with the base of rail; the spike should never have to be straightened while being driven.

(10) The outside spikes of both rails should be on one side of the tie, and the inside spikes on the other. The inside and outside spikes should be spaced as far apart as the face and character of the tie will permit. The ordinary practice should be to drive the spike two and one-half inches from the outer edge of the tie. The old spike holes should be plugged.

On page 61, it is recommended that the third line from the bottom be changed to read:

"and E=elevation of outer rail in
 inches at the gage line."

During the Buffalo meeting, subject No. 2 of the outline of work was discussed from the signaling and track standpoint, and the committee made the following recommendation, which was adopted:

"Where there is material leakage from track circuits, track fastenings should be so designed as to prevent contact between the metal and the ballast."

SPECIFICATIONS FOR SPRING AND RIGID FROGS.

The company will furnish the manufacturer one copy of the specifications and drawings.

The drawings will show the rail sections, splice drilling, angle, alignment and general dimensions.

The drawings are intended to co-operate with and form a part of the specifications. Dimensions should not be scaled. Anything which is not shown on the drawings, but which is mentioned in the specifications, or vice versa, or anything not expressly set forth in either, but which is reasonably implied, shall be furnished the same as if specifically shown and mentioned in both. Should anything be omitted from the drawings or specifications which is necessary for a clear understanding of the work, or should any error appear either in the drawings or specifications affecting the work, it shall be the duty of the manufacturer to notify the company, and he shall not proceed with the work until instructed to do so by the company.

Rail shall be first quality, of the section ordered, as called for by the _____ Company's rail specifications.

Filling between the main and wing rails, and between the main and easer rails, shall be rolled steel.

Raising blocks must be of cast steel.

Solid foot guards and beveled filler blocks not presenting a running surface may be of cast iron.

Foot guards when made of steel shall be not less than $\frac{3}{8}$ in. thick, of width shown on plans, shall fill the space between head and base of rail, and shall be bolted to the web of rail by bolts not less than $\frac{3}{4}$ in. in diameter. These foot guards shall be supplied at all places where protection is needed, and where conditions will not allow the above specified cast iron foot guards.

Bolts shall be of double refined iron. Bolt iron shall have a tensile strength of not less than 48,000 lbs. per sq. in., and an elongation of not less than 15 per cent in eight inches. When nicked on either side and then broken, the fracture shall be entirely fibrous and free from flaws and unwelded seams. Bolts must be round and true to size, with square heads and nuts. Threads must be accurately cut and nuts must have a wrench-tight fit. Each bolt must be provided with an approved head lock made of material not less than $\frac{1}{4}$ in. thick, preventing the bolt from turning, and a nut lock of approved pattern large enough to give full bearing for the nut. A $\frac{1}{4}$ -in. cotter pin must be placed outside of and close up to the nut after it is tightened. Beveled washers must be used wherever necessary to give head and nut a full square bearing; they must be wide enough to act as head locks. Bolts must be long enough to allow the nuts to be brought out from under the head of the rail, with a suitable washer no less than $\frac{1}{2}$ in. thick, so that the nuts may be readily tightened with an ordinary wrench.

Rivets shall be of good quality mild steel, with an ultimate tensile strength of 50,000 to 54,000 lbs.

Reinforcing bars shall be of wrought iron or soft steel.

Plates shall be of rolled steel.

Springs shall be of the best quality spring steel, and of dimensions and capacity shown on the plans. They shall meet the following tests.

(a) Each spring shall be placed on the testing machine and forced down solid four times.

(b) After the foregoing, each spring shall be placed on one end of a flat plate, and the distance between the plate and the other end of the spring measured by means of the standard depth gage; this measurement being the free length of the spring. The free length must conform to the plans within $\frac{1}{8}$ inch.

(c) Double springs shall be assembled and a load at least 25 per cent greater than the rated capacity of the spring shall be applied for thirty seconds. Upon release neither spring must vary from its original free length. If either one does so vary, it shall be rejected.

(d) The inner and outer coils of springs shall be coiled in opposite directions.

Spring covers shall be made of malleable iron.

Braces shall be made of malleable iron.

Stops and hold-downs shall be made of soft steel.
Anti-creeping device shall be made of soft steel.

WORKMANSHIP.

The workmanship must be first class. Bends shall be made accurately and with care, so as not to injure the material. They shall be in arcs of circles and not angles.

It is desired that the rails be bent cold. If heating is resorted to, it shall be done in such a manner as not to injure the rail. Welding in any part of the frog will not be permitted. Planing shall be true, and all abutting surfaces fit closely. Ends of rails shall be cut at right angles to the axis of the rail, except where otherwise shown on the plan. All burrs shall be removed.

Fillers shall fit the fishing angles and the web of the rail tight for a distance of $\frac{1}{2}$ in. above and below the base and the head, respectively, and still maintain the required flangeway. Where the brand of the rail interferes with the fit of the filler, the brand shall be chipped off flush. Fillers shall be grooved or cut out to fit over rivet heads.

Heel raising blocks shall fit the head, base and web of rail equally as well as the fillers are fitted.

Beveled fillers or solid foot guards shall fit the rail sufficiently well to maintain the required spacing.

The diameters of the rivets shall be of full size shown on plan, and the diameters of the rivet holes shall not be more than 1-16 in. greater than the diameters of the corresponding rivets. The rivets shall be of sufficient length to provide full, neatly made heads when driven. They shall be driven tight, bringing all adjacent parts in contact.

Rivet heads, when not countersunk or flattened, shall be hemispherical and of uniform size for the same size rivets. They shall be full and neatly made, and concentric with the holes. When the rivet heads are countersunk or flattened, they shall be flush with the tie plate, and fill the holes.

Reinforcing bars shall fit the fishing angles and web of rail throughout their length.

Plates shall be flat and true to surface.

Springs shall have the ends cut square with the axis, so that when the spring is placed on end on a flat surface it will stand perpendicular.

Spring covers shall be of such dimension as to permit a proper working of the springs, and shall be provided with a spring bearing for each end of the spring.

Braces shall fit the head and web of rail accurately.

Stops shall be so placed on plates as to hold the wing rail at $1\frac{1}{8}$ -in. opening at the $\frac{1}{2}$ -in. point. Hold-downs shall fit stops so as to allow at least 2 in. horizontal play and not more than $\frac{1}{8}$ in. vertical play.

The anti-creeping device shall fit accurately to the parts of the frog or angle bars.

Holes shall be drilled from the solid. No punching will be permitted except in case of bottom plates and washers. Drilling shall be accurately done, on bevel where necessary, and holes shall be made 1-16 in. less in diameter than the bolt to be used. Then the parts shall be assembled and the holes reamed so they are straight and true, with no offsets between the adjacent parts, and of such size as to give the bolts a driving fit for their entire length.

In lieu of the above specifications for drilling and reaming, the manufacturer may assemble and accurately fit all the parts, including the rail and fillers, before any drilling whatever is done; after the parts are securely clamped in their correct positions, the holes may be drilled through the entire mass to the exact diameter of the bolt.

The number of the frog, maker's name, weight of rail and the date shall be plainly stamped with $\frac{3}{4}$ -in. figures and letters on the flare of one wing rail for rigid frogs and the flare of both wing rails for spring frogs.

No paint, tar or other covering shall be used before inspection.

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The alignment and surface of all finished work shall be even and true, and shall conform to the angles specified.

INSPECTION.

Material and workmanship shall be at all times subject to inspection by a duly authorized representative of the company, who shall examine the material before it is worked in the shop. He will inspect the work during progress and will also inspect the finished product, with power to reject materials and workmanship found to be unsatisfactory. He shall have free access to the shops and mills at any and all times during the progress of the work.

The acceptance of any material by an inspector shall not prevent subsequent rejection if found defective after delivery or during the progress of the work, and such defective material if furnished by the manufacturer shall be replaced by him at his own expense.

All facilities, labor and tools necessary for the shop inspection shall be furnished at the expense of the manufacturer.

When the manufacturer furnishes the rails he shall supply the company with a certificate of inspection made by some competent person acceptable to the company.

The following ten requisites for switchstands are recommended:

REQUISITES FOR SWITCHSTANDS.

- (1) There should be no lost motion in parts.
- (2) Stands should have an adjustable throw on the foot.
- (3) The operating lever of ground stands should work parallel with the track.
- (4) Throwing apparatus should be so arranged that when the switch is set for movement of a train, it will be thrown to an extreme position and the throwing rod be locked independent of the latch on the stand lever.
- (5) The stand should be snowproof.
- (6) The connection between the throwing rod and the stand should be so arranged that it will be impossible to separate the throwing rod from the stand when the stand is set up in working position.
- (7) The stand should be so arranged that it can be easily inspected.
- (8) The target should not show clear signal for main track movements unless the points are up snug against the stock rail.
- (9) The targets shall conform to the drawing.

COMBINATIONS OF FROGS AND SWITCHES.

11-ft. switch points with No. 6 frogs and under.
16½-ft. switch points with frogs over No. 6, up to and including No. 10.

22-ft. switch points with frogs over No. 10, up to and including No. 15.

33-ft. switch points with frogs over No. 15.

Three frogs are recommended to meet all general requirements. These are No. 8, No. 11 and No. 16.

The committee further investigated the widening of gage on curves, and received and tabulated answers to their circular from 45 different railroads, and after considering these answers, recommended for adoption the following rule:

Curves eight degrees and under should be standard gage. Gage should be widened one-eighth inch for each two degrees or fraction thereof over eight degrees, to a maximum of 4 ft. 9½ ins. for tracks of standard gage. Gage, including widening due to wear, should never exceed 4 ft. 9½ ins.

The installation of frogs upon the inside of curves is to be avoided wherever practicable, but where same is unavoidable, the above rule should be modified in order to make the gage of the track at the frog standard.

The committee's attention was called to the method of measuring frogs, and upon special instructions from the board of direction to recommend a definition for frog number, recommend the following:

Considering that the frog angle is the angle between the gage lines of the point rails, that the axis of a frog is the line

which bisects that angle, and that the spread of a frog is measured at right angles to the axis, the number of the frog is the number of units measured on the axis in which the frog spreads one unit, from which the frog number is one-half the co-tangent of one-half the frog angle.

CONCLUSIONS.

The committee recommends:

- (1) That the recommendations contained in the report for substitution in the Manual of Recommended Practice be approved.
- (2) That the resolution regarding design of track fastenings with reference to track circuits be approved as good practice.
- (3) That the specifications for spring and rigid frogs and the requisites for switchstands be approved.
- (4) That four lengths of switch points be approved, and the four kinds of frogs and the combinations of frogs and switches, together with the practical leads submitted, be approved as good practice.
- (5) That the rule for widening of gage on curves be approved.
- (6) That the definition of the number of a frog, viz., that the number of the frog is one-half the co-tangent of one-half the frog angle, be approved.

These conclusions were adopted.

A discussion on the matter of leakage of current from track circuits brought out the information that some roads on which types of joint fastenings which hang below the rail are used, substitute plain angle bars for track in sinks or other wet territory where cinder ballast is a necessity.

STANDARD SPECIFICATIONS FOR CEMENT.

The report of the committee on Standard Specifications for Cement was presented by the chairman, Mr. H. G. Kelley, chief engineer of the Grand Trunk.

The work of the committee consisted in bringing the specifications up to date and putting them in line with the new standard of the American Society for Testing Materials. To do this it was necessary to amend paragraph 15, under "Natural Cement," page 102 of the 1907 edition of the manual, to read as follows:

"The minimum requirements for tensile strength for briquettes one inch square in cross-section shall be as follows, and shall show no retrogression in strength within the periods specified:

	Strength
24 hours in moist air.....	75 lbs.
7 days (1 day in moist air, 6 days in water).....	150 lbs.
28 days (1 day in moist air, 27 days in water).....	250 lbs.

One part cement, three parts standard Ottawa sand:
7 days (1 day in moist air, 6 days in water)..... 50 lbs.
28 days (1 day in moist air, 27 days in water)..... 125 lbs.

Paragraph 19, under "Portland Cement," page 103, to read:

"The specific gravity of cement shall not be less than 3.10. Should the tests of cement as received fall below this requirement, a second test may be made upon a sample ignited at a low red heat. The loss in weight of the ignited cement shall not exceed 4 per cent."

Paragraph 22, under "Portland Cement," same page, revised to read:

"The minimum requirements for tensile strength for briquettes one inch square in section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

	Strength
24 hours in moist air.....	175 lbs.
7 days (1 day in moist air, 6 days in water).....	500 lbs.
28 days (1 day in moist air, 27 days in water).....	600 lbs.

One part cement, three parts standard Ottawa sand:
7 days (1 day in moist air, 6 days in water)..... 200 lbs.
28 days (1 day in moist air, 27 days in water)..... 275 lbs.

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CONCLUSIONS.

The committee recommended that the standard specifications for cement be revised to conform with the amendments reported.

As standard specifications for cement have always been reported by the masonry committee, the special committee recommends that this practice be continued and that the masonry committee be instructed to incorporate the revisions to the standard specifications for cement in its report and that the revised specifications appear in the manual as a part of the masonry committee report; and as the masonry committee formerly handled the question of standard specifications for cement, which work is naturally a part of the work of the masonry committee, the special committee further recommended that this work be reassigned to the masonry committee and that the special committee be dismissed.

The conclusions were adopted in the form presented.

MASONRY.

The report on masonry was presented by the chairman of the committee, Mr. A. O. Cunningham, chief engineer of the Wabash

The following conclusions were adopted:

(1) That the specifications for natural and Portland cement, now appearing in the "Manual of Recommended Practice," be amended to conform to the version given in the report of the special committee on standard specifications for cements.

(2) That the specifications for Portland cement concrete, now appearing in the manual be withdrawn, and that the specifications for plain and reinforced concrete given in Appendix A of this report be adopted and incorporated in the "Manual of Recommended Practice."

(3) That the recommended practice for designing reinforced concrete structures in Appendix B be adopted and incorporated in the manual.

(4) That the report on waterproofing masonry be received as information and the investigation continue.

(5) That the report of the joint committee on concrete and reinforced concrete be received as information and printed in the proceedings.

BUILDINGS.

The report of the committee on buildings was presented by its chairman, Mr. O. P. Chamberlain, chief engineer of the Chicago & Illinois Western. The following recommendations, which involve changes in, or additions to, the "Manual of Recommended Practice," were adopted:

TURNTABLE.

(a) The turntable should be not less than 75 ft. in length.
(b) The table should be operated by power, preferably electric.

(c) If electric power is used, the wires should be carried in a conduit up through the center of the pivot masonry and the turntable center.

TURNTABLE PIT.

The side walls of the turntable pit should be of concrete or brick with wooden coping not less than six inches thick, and the ties under the circle rail should be supported on concrete.

DOOR OPENINGS.

The clear opening of entrance doors should be not less than 13 ft. in width and 16 ft. in height.

SMOKE JACKS.

Smoke jacks should be fixed; the bottom opening should not be less than 42 in. wide, and long enough to receive the smoke from the stack at its limiting positions, due to the adjustment of the driving wheels to bring the side rods in proper position for repairs. The bottom of the jack should be as low as engines served will allow, and it should be furnished with a drip trough; the slope upward should be gradual to the flue; the area of the cross-section of the flue should be not less than 7 square ft., and the material used, non-combustible.

DROP PITS.

Drop pits should be provided for handling truck wheels, driving wheels and trailer tender wheels.

ELECTRIC LIGHTING.

For general illumination there should be an arc lamp or something equally efficient in each space between stalls. There should also be plug outlets for incandescent lamps in each alternate space between stalls.

PIPING.

(b) Compressed air with from 80 to 100 lbs. pressure which can be used for operating air tools and also for hoists and blowing and steam with 100 lbs. pressure for use in raising boiler pressure should also be provided. The steam outlet is needed near the front end of the boiler and the incandescent light plugs; the blow-off pipe, the air, the washout and refilling water, and the cold water connections should be near the front end of the firebox. Connections need only be provided in alternate spaces between stalls.

TOOLS.

There should ordinarily be facilities for the location of a few machine tools, preferably electrically driven.

OIL HOUSES.

(4) The delivery system from the storage tanks to the faucets should be such that the oil can be delivered quickly and measured automatically. The delivery should also be such that there will be a minimum of dripping at the faucet and that the dripping be drained back to the storage tanks.

(5) Openings for ventilation should be provided above the level of the top of the tanks.

(6) Lighting, when required, should be by electricity and heating by steam.

The matter of fire protection of oil houses was referred back to the committee for further report.

SECTION TOOL HOUSE.

Class A roads:

House, 14x20 ft., with long dimension parallel to track; house to have sliding door 8 ft. in clear at extreme end on track side to permit the storing of hand car.

Class B:

House, 14x20 ft., with long dimension parallel to track; house to have sliding door 8 ft. in clear at extreme end on track side to permit the storing of hand car.

Class C:

House, 10x14 ft., with the short dimension parallel to the track, with double swinging door, swinging out on the end nearest the track.

The report on roof coverings, was, by request of the committee, referred back for further consideration.

The recommendations of the committee, as presented, had embodied quality of roofing material and siding, and specified that there should be no glass in the windows, but, after discussion, this was stricken out. Finally, after discussion, the recommendations were cut down to cover dimensions only, and so adopted.

ROADWAY.

The report of the committee on roadway was presented by the chairman, Mr. Geo. H. Bremner, of the Burlington. The following recommendations, involving changes in, or additions to, the "Manual of Recommended Practice," were submitted and adopted:

DEFINITIONS.

Slide—The movement of a part of the earth under the force of gravity.

Washout—The carrying off of the permanent way by the impact and erosion of flood waters.

Bog—Soft spongy ground, usually wet and composed of more or less vegetable matter.

Berne—(a) The space left between the top or toe of slope and excavation made for ditches or borrow pits.

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RECORDS AND ACCOUNTS.

The report of the committee on records and accounts was presented by the chairman, Mr. H. R. Safford, of the Illinois Central. The following conclusions were adopted:

(1) The use of red ink with black arrows for dimension lines on all drawings.

(2) Combination of forms M. W. 1020 and 1021.

(3) Revision of form M. W. 1022, as represented on revised form 1022.

(4) Use of the following titles for forms covering drafting practice:

(a) For conventional signs on pp. 132 to 138, inclusive, 1907 manual: "Conventional Signs for Use on Signal and Interlocking Plans."

(b) For form M. W. 1020 and 1021: "Conventional Signs for Use on Topographical and Right-of-Way Maps."

(c) For form M. W. 1022: Conventional Signs for Structural Drawings:

(d) For form M. W. 1016: "Conventional Signs for Track Charts."

(e) For form M. W. 1015: "Conventional Signs for Working Profiles."

5. It is recommended that the signs composing the groups above indicated be published in pamphlet form and distributed to the membership of the association at a nominal price. Attention is called to the grouping of the conventional signs to enable the desired sign to be more easily found.

(1) To recommend to the board of direction that the committee be authorized to submit different forms, if necessary, calling for the same information to suit varying organizations.

(2) To abolish form M. W. 1000.

(3) To consider further forms M. W. 1003, 1005 1006, 1007 and 1009.

(4) To indicate on form M. W. 1010—

(a) Data showing width of streets and alleys.

(b) Distance along street lines which intersect the right-of-way line.

(c) A line representing the original center line of the main track.

Mr. L. C. Fritch thought that additional conventional signs should be used to indicate telephone and electrical power lines across the tracks.

Mr. J. O. Osgood said that he had varied from the recommendations of the committee to the extent of using black lines in all cases, as considerable expense was involved in drawing red lines on the large number of blue prints which are necessary for ordinary use.

The committee reported as information an interpretation of the word "estimate," as follows:

"In the indiscriminate use of the word 'estimate' it has a dual application in the fact that it is used both to indicate an approximate quantity as well as to indicate the exact quantity of completed work, as the ordinary practice is to call a final statement of completed work a 'final estimate.'

"It therefore appears to the committee that this term can be applied only to the preparation of statements of contemplated construction where the exact quantities of work are not known, and that statements of completed work should not be called estimates. The committee has placed the above interpretation upon the word estimate in the instructions given by the board of direction, and recommends that the use of this term be applied only to such statements as are prepared for contemplated construction work, for statements prepared to show the progress of such work, and statements forming the basis for partial payments; and that the word 'statement' should be used for statements showing the actual work done.

"It is not considered necessary to embody in this report a formal definition of the word 'estimate' for adoption by the association, but it is recommended that the use of the word 'estimate' be confined to the purpose above outlined, and it is sug-

Berne—(b) An approximately horizontal space introduced in a slope.

Earthwork—The moving of masses of earth by artificial means. Profiles should be made complete in regard to distribution of material.

There should be recognized three widths of roadbed for standard-gage railways, and these should be selected to suit the density of traffic. These widths should be 14, 16 and 20 ft.

Recommended that the specifications for the formation of the roadway be changed in the following particulars: Paragraph 11, now reading as follows: "Fences, grain, grass or other annual growths and other movable property on the right-of-way shall be carefully removed or piled up, as may be directed, without extra charge, it being understood that the price for grading covers these items. In localities where isolated trees and buildings exist, payment shall be made for their removal at a price to be agreed upon," be amended to read:

In localities where isolated trees and buildings exist, payment shall be made for their removal at a price to be agreed upon.

In crossing bogs or swamps of unsound bottom, for light fills a special substructure of logs and brushwood may be required, the logs forming this foundation to be not less than six inches in diameter at the small end. If necessary there shall be two or more layers crossing each other at right angles, the logs of each layer being placed close together, with broken joints, and covered closely with brush; the bottom layer shall be placed transversely to the roadway and project at least five feet beyond the slope stakes of the embankment.

(7) The weighting of the toe of the slopes to restore equilibrium may sometimes be found efficient.

Original recommendations as to tunnel construction were submitted and adopted, as follows:

1. That the form and dimensions of the clear space to be provided for single and for double-track tunnels on tangent conform to these diagrams:

2. For tunnels on curved track, the dimensions of the section should be increased and the track displaced from center of tunnel so as to give substantially the same clearance as is given on tangent by the sections above.

3. For double-track tunnels the drainage should be provided for by the construction of a concrete channel midway between the tracks.

4. The rate of grade in long tunnels and on approaches should be reduced so as to be 25 per cent less than that of the ruling grade.

5. Concrete should be used for the permanent tunnel lining except where local conditions will injure the concrete before there is time for it to harden.

In the event that a brick lining be used, that portion of the arch for a horizontal distance of five feet on each side of the center line of each track, should be laid with vitrified brick in rich Portland cement mortar.

The discussion on Conclusion 4, the necessity for grade reduction in tunnels, on ruling grades, brought out various reasons supporting the conclusion, such as the desire to reduce the work of locomotives in tunnels on ruling grades, so that they will emit less smoke; a desire to have the trains pass through the tunnels as quickly as possible; the reduced adhesion of locomotives in wet tunnels. Mr. W. H. Courtenay, chief engineer of the Louisville & Nashville, spoke against the practice of locating summits in tunnels.

M. H. G. Kelley, chief engineer of the Grand Trunk, spoke of the importance of specifying height of tunnels from base of rail instead of from top of rail, in view of legal limitations, as in Canada. When thus specified rails of higher section can be used in renewals without violating the law.

By motion, it was voted to amend recommendation No. 1, so as to refer height of tunnel to base of rail instead of top of rail.

Recommendation 4 was referred back to the committee, with instruction to confer with the committee on economies or railway location.

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gested that if this meets with the approval of the association it be followed in the work of other committees."

WATER SERVICE.

The report of the committee on water service was presented by the chairman, Mr. C. L. Ransom, resident engineer with the Chicago & Northwestern. The following minor changes, for revision of the "Manual of Recommended Practice," were adopted:

Paragraph 4, page 34. The hardness of water due to carbonates of lime and magnesia can be removed at a moderate expense for chemicals by the use of lime alone, without adding any soluble salts to the softened water.

The hardness of water due to sulphates of lime and magnesia can be removed by the use of soda ash, a more expensive chemical. The chemical reaction removes sulphates of lime and magnesia, and leaves soluble sulphates of soda, which increases the tendency to foam.

The heading of diagram No. 4, page 2, Vol. 9, now reading: "Steam cylinder pressure required per pound water pressure in direct acting steam pumps of various cylinder ratios and efficiency" to be changed to "Cylinder ratios in direct acting steam pumps for different steam pressures per pound of water pressure for various efficiencies."

In the discussion of the specifications for water tanks, Mr. Geo. W. Kittredge, chief engineer New York Central asked why the committee had omitted mention of round and half-round hoops. The inquiry gave rise to a considerable amount of discussion. Mr. J. C. Nelson of the Seaboard Air Line, cited a case where flat hoops had failed in six years. Mr. Stein, of the Central R. R. of New Jersey, had seen comparisons of the service of round and flat hoops quite favorable to the round hoop. Mr. C. F. Loweth, of the Chicago, Milwaukee & St. Paul, said that after considerable experience with round hoops had adopted them as standard. Mr. C. E. Lindsay (New York Central) has found round hoops satisfactory, except for single objection that they crease the wood. For this reason he is now trying three-quarter-round hoops. As the result of the discussion the committee agreed to mention round and half-round hoops in the report. It is commonly the practice to paint flat hoops on both sides.

Mr. W. C. Cushing, speaking of steel post supports for water tanks, preferred four supports to twelve, which number is used to some extent, for the reason that in the twelve-post support, if economically designed, the metal in the shapes is too thin, and slight waste by corrosion is largely a proportion of the section.

The following conclusions were adopted:

(1) The conclusions under "definitions and useful information" are essential to a full understanding of the subject and should accompany the diagrams when published in the Manual.

(2) The views of water columns and the diagrams of head lost therein are recommended for publication in the Manual.

(3) The diagrams of head lost in straight pipe are recommended for publication in the Manual.

(4) The diagrams for head lost in tees and elbows and for values of the velocity heads are recommended for publication in the Manual.

SIGNS, FENCES AND CROSSINGS.

The report of the committee on signs, fences and crossings was presented by the chairman, Mr. W. D. Williams, chief engineer of the Cincinnati Northern. The work of the committee approved was certain matter revised for the manual and recommendations made in the rewriting and revision of the detailed matter accompanying conclusions adopted at tenth annual convention, and plans accompanying it affecting the proper construction of grade crossings and snow fences, snow sheds and recommended methods for snow removal.

The discussion centered chiefly on points intended for the instruction of the committee in its future work. The remarks referred to crossing flangeways, and drain tile.

VISIT OF PRESIDENT TAFT.

The convention was fortunate in being honored by a visit of the President of the United States, William H. Taft. For this event a recess was taken following the hearing of the report on signs, fences and crossings.

The President was introduced by President McNab, who took occasion to explain that, being a Canadian, he doubly appreciated the honor of introducing him to the audience. The remarks of President Taft were as follows:

"Mr. Chairman and gentlemen of the Maintenance of Way convention, I am very glad to meet and cultivate the good graces of a Canadian just at this time. I suppose that I shall surprise you if I tell you that I have done a good deal in the way of railroad repair and railroad construction. There was a time between 1893 and 1900 when I occupied the position of U. S. Circuit judge in that part of the country where most of the railroads went into the hands of the receiver; and if you know anything about receiverships, as I doubt not most of you do, being railroad men, the first thing a good receiver does is to consult his maintenance of way man and his engineer to see how much in the way of receiver's certificates he ought to issue to make the road safe to carry passengers.

"I was an undertaker in the burying of I don't know how many railroad companies in that Sixth Circuit, and in the reconstruction of thousands of miles of railroad; and at that time I was able to follow with interest the prices of steel rails and how far a million dollars would go in helping along a railway that needed new steel. I came then to know what I ought to know, that the maintenance of way man is the man after all into whose keeping is given the safety of ninety millions of people.

"The engineers who make the roadbed and direct the laying of the track and the building of the bridges are the persons who affect not only our comfort as we go over the road, but our safety, and makes the question as to whether we will return to our wives, or otherwise, a certainty.

"I have traveled 14,000 miles this year and I am bound to say that the traveling was in every respect delightful; the ways were well maintained, and when we had a jolt we attributed it not to the civil engineer of the road, but, knowing something about these things, to the carelessness of the locomotive engineer.

"But I did not come, gentlemen, to make a speech on the subject of railroads. I know that I am looking into the faces of the railroad conductors of this country. I am glad to be here and to extend to you a congratulatory word on the improvement that has gone on in railway construction and railway roadbeds within the memory of the youngest of us, so that today, you who can look back a generation can see an improvement that you certainly did not expect when you began your profession. We have not in this country followed this progress up by the enactment of laws that shall protect the public against accident. I mean not so much the traveling public, because I think the statistics are not so unfavorable in that respect, but compare well with those of foreign countries. The laws to which I refer are laws which will keep the roadbed free from trespassers, which will require gateways and such protection against the negligence of the public as will reduce to a minimum the class of accidents in which the public have only themselves to blame.

"I do not know whether this is the fifth or sixth speech that I have attempted to make today, but I wish to express to you my great pleasure at your welcome, and especially from one who comes from the land of our Northern neighbor."

YARDS AND TERMINALS.

The report of the committee on yards and terminals was presented by the chairman, Mr. F. S. Stevens of the Philadelphia & Reading. The main work of the committee was recommendations as to the revision of the manual, and these were adopted.

A vote was passed thanking the Road and Track Supply

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RAILWAY ENGINEERING

AND MAINTENANCE OF WAY.

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Association for the splendid exhibition of railway appliances at the Coliseum.

ELECTION OF OFFICERS.

The following officers were elected:

President—L. C. Fritch, chief engineer Chicago Great Western.
Second vice-president—Chas. S. Churchill, chief engineer Norfolk & Western.

Secretary—E. H. Fritch (re-elected).

Treasurer—C. F. Loweth, engineer and superintendent of bridges and buildings, Chicago, Milwaukee & St. Paul.

Directors (for three years)—Robert Trimble, chief engineer maintenance of way Northwest System, Pennsylvania Lines West, and F. S. Stevens, superintendent Philadelphia & Reading.

Meeting of Railway Signal Association

The stated meeting of the Railway Signal Association was held at the Congress Hotel, in Chicago, March 14, last. The meeting was called to order at 10:30 by Vice-President C. C. Denney, signal engineer of the Lake Shore. The first business considered was reports of the various committees.

Mr. A. H. Rudd, signal engineer of the Pennsylvania, chairman of Committee No. 1, reported that his committee had considered the advisability of the use of signals moving in the upper left-hand quadrant. After several meetings, it decided against using these signals. Such signals are not in accord with the requisites of the American Railway Association, the Railway Signal Association and the Maintenance of Way Association have both recommended signals working in the upper right-hand quadrant, and such standard practice is well established. On posts having several signals, in narrow places, as in rock cuts and on bridges, the lower signal might not clear trains. Such signals could not be used interchangeably with right-hand signals, as the back of one might be confused with the other.

Mr. Stevens, signal engineer of the Santa Fe, objected to the rejection of upper quadrant left-hand signals by the committee. He suggested it would be better to report only against the use of such signals. Personally, he thinks them superior to right-hand signals for many situations, and would gladly use them where practicable to do so.

The sub-committee on standard designs submitted a number of drawings of ladders, ladder clamps and stays, ground signal masts, bases for bracket and bridge signal masts, bracket posts and bridge signal masts and pinnacle casting. Mr. Stevens was opposed to the use of a third arm on signals generally, and if necessary at all, would not place it as close to the two others as the committee had recommended, namely, 6 ft. below the second arm from the top, the second arm being 7 ft. below the top arm. As the standards will not come up for final adoption until presented at the annual meeting this fall, this discussion was intended to be only advisory to the committee.

Mr. Rudd said that it was the practice on the Pennsylvania to put the third arm 11 ft. below the second. He thought that the distance between the second and lower arms should be greater than that between the top and middle arms. He thought it inadvisable to make the spacing as small as that recommended. Mr. Mock, electrical engineer, Detroit River Tunnel Co., told of the trouble which the committee had experienced in making this spacing as long as acceptable to the majority. It requires very high signals to make the lower arm clear traffic where the post stands close to the track. There was not much further discussion and it was voted to recommend the committees' work to the annual convention for adoption.

Drawing No. 1035, for standard ground signal masts, was next discussed. For one-arm signals the plan shows a post 26 ft. 8 ins. high, with the center line of the arm 22½ ft. above base of rail. The two-arm signal post is 33 ft. 8 ins. high, with the lower arm 22½ ft. above base of rail and the top arm 7 ft.

higher. The plans for one-arm and two-arm signal masts were approved. For a three-arm mast the committee had recommended a post 38 ft. 8 ins. high, with arms 22½ ft., 28½ ft., and 35½ ft. respectively, above base of rail. It was voted to refer this design to the annual meeting.

The committee's design of a base for bracket and bridge signals was also adopted. The committee's recommendation of bracket and bridge signal masts with 3½ ft. as the spacing between the top chord and first arm was approved.

Plan No. 1040, pinnacle casting 23 inches high, and another plan of pinnacle 5 inches shorter to be submitted at the annual meeting, were approved.

It was voted that Design A of upper-quadrant spectacle casting, submitted at the last annual meeting, and shown on page 417 of the proceedings for last December, be approved.

Mr. C. J. Kelloway, signal engineer, Seaboard Air Line R. R., reported progress for committee No. 2, on mechanical interlocking.

Mr. B. H. Mann, chairman of committee No. 3, and the various chairmen of subcommittees under him on "Power Interlocking," made separate reports. In connection with these the scheme of "neighborhood" meetings for committees was explained. The idea is to have present at committee meetings as many persons interested as possible from the country adjacent to the place of meeting, to bring out for the use of the committee the ideas of as many people as possible. So far this plan has not been generally applied, it being in an experimental stage. The scheme was very enthusiastically indorsed by the meeting.

Mr. A. G. Shaver, signal engineer of the Rock Island, chairman of committee No. 4, "Automatic Block," reported progress, as did Mr. L. R. Mann, of the Missouri Pacific, vice-chairman of committee No. 5, Manual Block; Mr. R. C. Johnson, of the New York Central, chairman of committee No. 6, Automatic Stops and Cab Signals; Mr. C. C. Anthony, of the Pennsylvania R. R., chairman of Committee No. 7, Subjects and Definitions; Mr. W. H. Elliott, New York Central, chairman of committee No. 9, Wires and Cables; Mr. C. C. Rosenberg, secretary committee No. 10, Electric Signaling for Electric Railroads; Mr. W. J. Eck, Southern Ry., for the special committee on Promotion of Signaling Education, the special committee on Lightning Arresters, and the special committee on Storage Battery, made no report.

Next to come before the association was a paper on "Lightning Protection," by Mr. Otto Holstein, chief train dispatcher, Central Ry. of Peru. This paper is published in another column. Owing to the absence of Mr. Holstein, there was no discussion. A vote of thanks was extended to Mr. Holstein for this paper, with a request that further information of experience with any or all lightning arresters on his road be communicated to the association.

A paper on "Soda-Copper Oxide Primary Cell on Track Circuits," was read by Mr. E. L. Marshall, of the National Carbon Co. The object of this paper is the discussion of primary batteries for track circuit work, attention being devoted principally to a comparison of the soda-copper oxide cell with the gravity cell. Since track conditions determine, in a large measure, the length of service life, Mr. Marshall considered first some questions relative to track circuits.

The discussion of this paper was very brief, and no new facts were brought out.

Mr. H. M. Beck, of the Electric Storage Battery Co., next read a paper on "The Portable Storage Battery in Automatic Block Signal Service."

Mr. Stevens commented on the larger labor force necessary to take care of storage batteries, compared with that required with the use of primary cells. The primary cell needs no attention for a year, whereas storage batteries require either

(Continued on page 216)

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RAILWAY ENGINEERING

AND MAINTENANCE OF WAY.

BRIDGES-BUILDINGS-CONTRACTING-SIGNALING-TRACK

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In remitting, make all checks payable to the Railway List Company. Papers should reach subscribers by tenth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.

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Vol. VI.

Chicago, March, 1910

No. 3

Articles on Railway Signal Standards

Our series of articles on railway signal standards are attracting very favorable attention, if we may believe reports that have reached us from railroad officials and supply men. We believe that they are supplying a much needed medium not otherwise available, of exchange of ideas between the various signal departments. Only by knowing what the other man is doing and comparing the standards of the various roads is any one able to adopt the best possible methods. The Railway Signal Association is seeking to bring about uniformity of practice in signaling by perfecting specifications, plans and rules that can be universally adopted. We believe that our series of articles should prove of value to the association in this work, also.

There are in the association 517 senior active members entitled to vote on standards. Of these, only 65 are signal engineers, or signal department heads connected with railroads in the United States and Canada, who necessarily are men of very wide experience. Of the rest, 19 live in Europe, Asia, Africa, South and Central America, and 119 are not signal officers, but are instructors in schools and colleges, consulting engineers, officials of the civil, bridge and building, or maintenance of way engineering departments and operating officials. It is obvious that except for those who are members of committees, these men have not the time necessary to devote to personal inquiry regarding standard practice. Even committee members can find time only to investigate the subjects assigned to their own committees. It is our endeavor to provide the means of such investigation, also to supply the manufacturers with data which will enable them to make quick estimates on installations according to the standards of any particular road.

There are 333 junior members of the association, who cannot vote on standards, yet who are greatly interested in signaling, as is evidenced by their profession and membership. The ma-

jority of them will, in all probability, some day be senior members, and even now we feel that we can contribute to their efficiency and breadth of view by supplying them with the information contained in our articles.

We therefore desire to include all these men together with any of the signal engineering profession who do not happen to be members of the association, on our subscription list; which already resembles a very complete roster of the engineering profession in general.

When the subject of automatic block signals shall have been sufficiently covered, it is our intention to take up other signaling subjects in the same manner until the field has been entirely covered, when, no doubt, unless the association has accomplished its object, we shall have to start all over again.

The Signal Department

Perhaps the most notable feature of the Lake Shore signal standards published this month is the ingenuity displayed in the design of circuits. Safeguards have been thrown about the control apparatus until it is difficult to see how false clear failures can occur in the ordinary course of events. There are, however, one or two improvements that we venture to suggest might be worth while. One is to break both sides of the signal operating circuit when the control relay is de-energized, thus getting rid altogether of troubles due to grounds; another is the provision of a separate line battery so as to leave the operating battery free to work the signal only; this would be an additional precaution against grounds and stray currents. Both these ideas have been thoroughly tried out on several roads and found efficient. However, with the splendid maintenance organization on the Lake Shore, they may not be necessary. We understand that it was the Lake Shore signal department that first broke away from the practice of having separate electrical and mechanical repairmen, thereby developing "all around" signal maintainers who could cover any kind of trouble. The Lake Shore was also the first road to use storage batteries changed from line extensively for signal operation. It was also the first trunk line railroad to achieve continuous automatic block protection between principal terminals; the break at Grand Crossing is of no importance, and need not be considered. Originally a left hand road, the Lake Shore is rapidly changing to right hand running. Nearly half the work has been completed in less than a year. The changes made necessary in signal arrangements, especially at interlocking plants, are enormous, yet so far Mr. Denney and his men have carried it on with no delays to trains. This is a performance of which any road might well be proud.

Owing to the serious illness of our editor, Mr. Rehm, we are forced to postpone the publication of "Track Standards."

Mr. Rehm has had this matter under his personal supervision, and therefore it has been thought best to await his recovery. He is now rapidly improving and from present indications he should be able to assume charge again in time to bring it out within six weeks.

Now that the convention of the Maintenance of Way Association and the meeting of the Signal Association are over and the smoke of battle has cleared somewhat, we find that the proceedings of the two associations are so interesting that we have reported them rather fully. In fact, we have made this a convention number and have, in so doing, sacrificed, perhaps, some other things in our endeavor to make reports complete. Space is, of necessity, limited and, therefore, we have used what we had for what we believe our readers will consider the most important happenings of the month.

To illustrate the interest taken in our Maintenance of Way Department, we publish herewith a letter from California.

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April, 1910.

We shall take up this matter in due course and shall treat it fully and thoroughly as is our practice.

"Editor Railway Engineering":—

"When your space permits, I would thank you to call for a discussion of track construction, methods, estimate cost of laying ties, and steel on new work and reconstruction. Average cost of cuts and fills per cubic yard, and methods of distributing steel and ties on new work.

"Roadmaster"

The Ultimate Consumer

In these days of high tariff, high cost of living and general political agitation, the "ultimate" consumer has been brought prominently before the public. You all know who he is—the man that *uses the goods*, the man who comes into contact with things, machinery, tools, rolling stock and all supplies. The head of a railroad department may specify the class of ma-

terial he wants, and the purchasing agent order it and the storekeeper distribute it, but who uses it? On what does the specifications of the department head depend? On the experience of the *man on the road*, the men who do the work, who apply the goods—the ultimate consumers. If these men learn of a device which they think would be better than what they are now supplied with or which would aid them in their work, they are going to agitate the subject all the way up, and *their opinion counts*. Railway Engineering reaches not only the officials of the railroads but the *men on the road* also. It reaches the ultimate consumer. The other day a manufacturer informed us of his own accord that he got more replies from his advertisement in Railway Engineering than from those in all other technical journals combined. Therefore this advertisement is his most valuable investment in publicity. Why? Because the men who wish to *use* his product read Railway Engineering. Advertise in Railway Engineering and *get results*.

The Signal Department

Railway Signal Standards

No. 5 Lake Shore & Michigan Southern

This road is in a transition stage. Heretofore all signals installed have been of the lower quadrant, 60° two position type of the same general appearance as that shown in Fig. 59. It is the intention, we understand, to install upper quadrant, three position automatic block signals and for this purpose signals substantially as shown in Figs. 7, 8, 9 and 10 will be used. Upper quadrant three position interlocking signals are now standard for all new work and renewals. In Figs. 81 and 82 are shown respectively, the home and distant signal blades used for lower quadrant signals. Night color indications are as follows: White for clear, green for caution, red for stop. Both normal danger and normal clear circuits are used. Signals are operated both by electric motor and liquified gas.

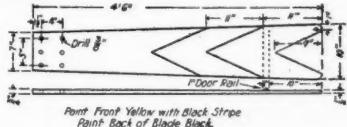


Fig. 81. Home Signal Blade, Lake Shore & Michigan Southern.

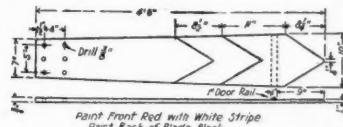


Fig. 82. Distant Signal Blade, Lake Shore & Michigan Southern.

Signals are operated and line relays controlled by the same battery. Caustic soda or potash and storage battery are in use for this purpose. Storage battery is charged from line circuits, current being generated in a charging station containing a gasoline engine and generator with necessary switchboards. A plan of such a charging station is shown in Fig. 83.

Storage battery is usually housed in the base of a special battery and instrument case illustrated in Figs. 84 and 85. On top of this case is mounted a pinnacle very similar to those used on the cable posts shown in Figs. 32 and 87 to admit wires to the interior. Below this pinnacle is a cross arm to which wires from the pole line are fastened. This case, which contains the lightning arresters, relays, charging switches and other instruments required for the control of the signal, is

mounted on a concrete foundation adjacent to the signal foundation, Fig. 86. Where such an instrument case is not needed, a relay box mounted on an iron cable post carrying a cross arm, Fig. 87, is used. On normal clear circuits five cells of storage battery are used to operate a signal. For normal danger circuits, from sixteen to eighteen cells of potash or soda battery are used. This battery is housed in a concrete well, iron box, or case at base of signal post below the mechanism.

Foundations for a ground signal and ladder are shown in Figs. 88 and 89 respectively. The depth and size of bottom as shown for all foundations are minimum dimensions in each case and may be made greater where nature of soil or other conditions require. A cast iron foundation for relay or junction box post is shown in Fig. 90. Signals, battery receptacles, and other apparatus are arranged on the ground as shown in Figs. 91 and 92.

Track battery consists either of two gravity cells or one storage cell per section. Gravity battery is housed in cast iron chutes 7 ft. deep, very similar to that illustrated in Fig. 47. The elevator used is shown in Fig. 93. A separate pole line for signal circuits is not used, the wires are strung on the same poles with the telegraph and telephone line. A standard arrangement of wires for signal purposes, Figs. 94, 95, is always followed. The common return circuit is broken every ten miles.

Bonding is done substantially as shown in Fig. 41. Bootlegs are made and installed as shown in Fig. 96.

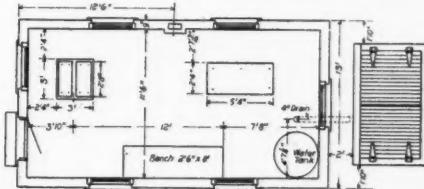


Fig. 83. Brick Charging Station, Lake Shore & Michigan Southern.

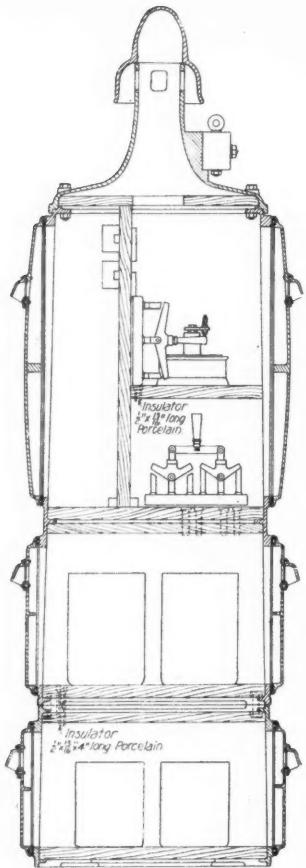


Fig. 84. Battery and Instrument Case, L. S. & M. S.

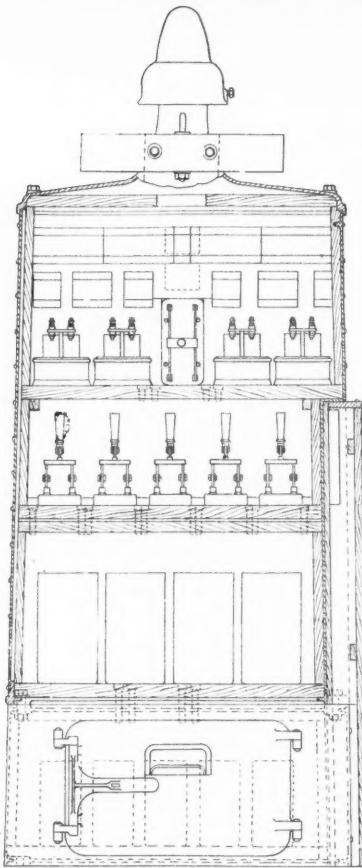
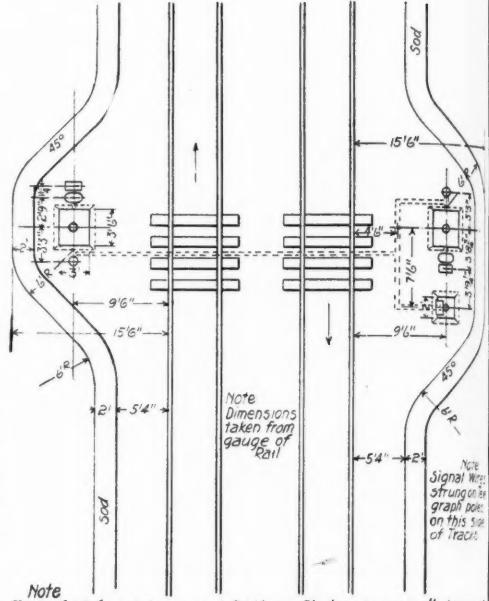


Fig. 85. Battery and Instrument Case, L. S. & M. S.



Note
Tops of all foundations and Battery Chutes, Level with base of Rail. Lower edge of opening in back of Gas Chute is $1\frac{1}{2}$ " above top of Foundation.

A wooden relay box is shown in Fig. 97. The same design is used for a junction box and is mounted on an iron post.

Figs. 98, 99, 100, 101 show how switches are protected. The location of switch indicators with reference to the switch is also illustrated. Switch indicators are of the lower quadrant, semaphore type and are used at all switches in track protected by automatic block signals. They are arranged to announce a train when it is approaching the distant signal for the block in which the switch occurs.

The Lake Shore was originally a left-hand road, but is now being changed over for right-hand running, consequently one of the typical circuit plans shows signals arranged for left-hand running. Normal clear circuits for double track are of two

kinds, those using line relays, Fig. 102, and those without line relays, Fig. 103, the line circuits going direct to the clutch coils. The home signal control circuit is always broken through controllers on facing point switches and the points of cross-over relays. It will be noted that a device is used to prevent the home signal from clearing should the distant signal stick clear with the home at stop. In one case the track relay is wired with a "stick" circuit controlled by a circuit controller actuated by the distant arm, and in the other case a similar circuit controller is arranged to work in connection with the home control relay.

Typical circuits for the control of normal danger signals are shown in Fig. 104. The home control circuit is always taken

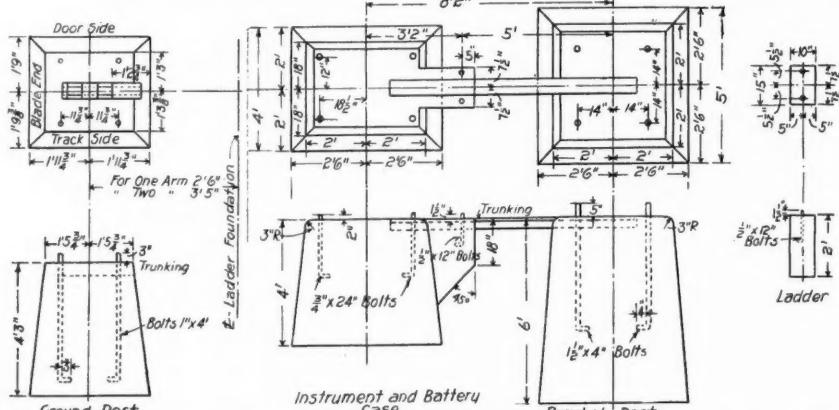


Fig. 88. Signal Foundation, L. S. & M. S.

Fig. 86. Foundations for Bracket Post and Instrument Case, L. S. & M. S.

Fig. 89. Ladder Foundation.

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AND MAINTENANCE OF WAY.

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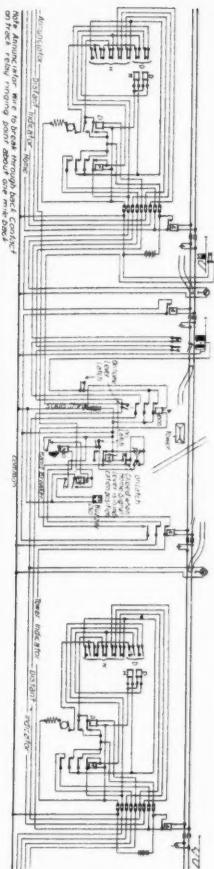


FIG. 102. TYPICAL CONTROL CIRCUITS FOR NORMAL CLEAR AUTOMATIC BLOCK SIGNALS AND SWITCH INDICATORS WITH LINE RELAYS.

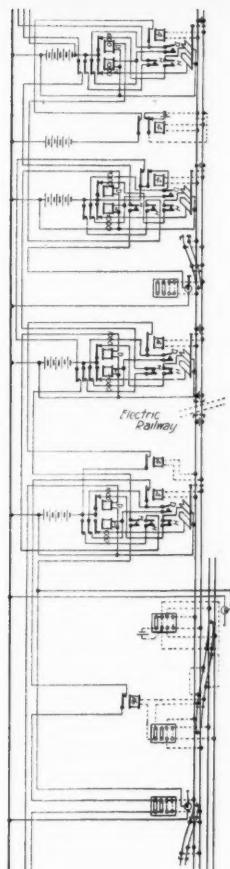


FIG. 103. TYPICAL CONTROL CIRCUITS FOR POWER-OPERATED SIGNALS AT SLOTTED MECHANISMS.

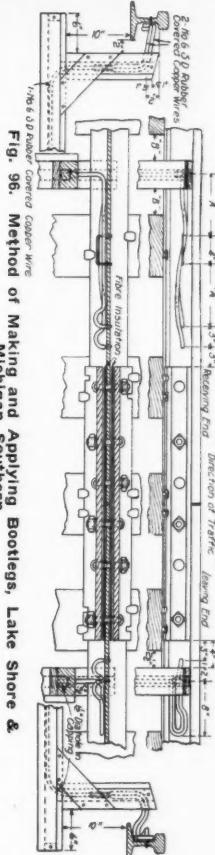


FIG. 96. METHOD OF MAKING AND APPLYING BOOTLEGS, LAKE SHORE & MICHIGAN SOUTHERN.

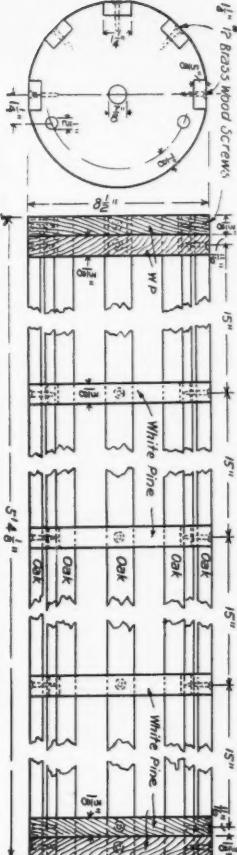
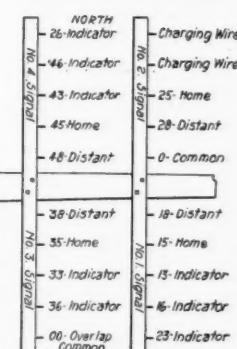


FIG. 93. BATTERY ELEVATOR, LAKE SHORE & MICHIGAN SOUTHERN.



FIGS. 98-99-100-101. SWITCH PROTECTION IN AUTOMATIC TERRITORY.

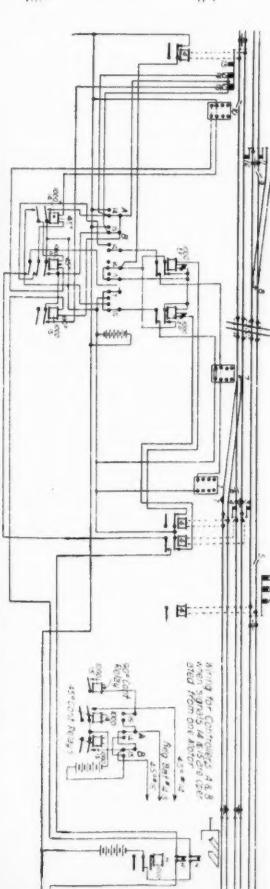
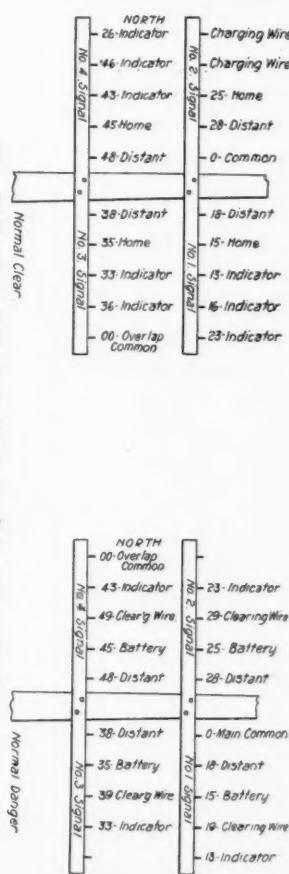


FIG. 104. TYPICAL INTERLOCKING, LAKE SHORE & MICHIGAN SOUTHERN.

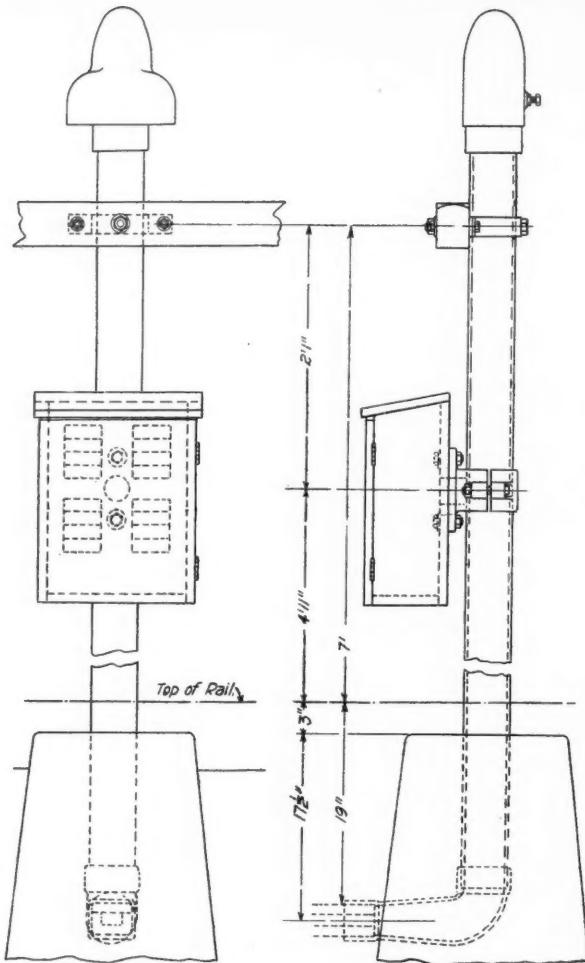


Fig. 87. Cable Post With Relay Box, Lake Shore & Michigan Southern.

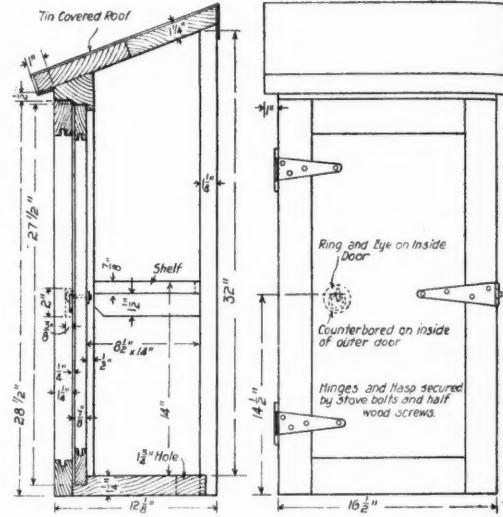


Fig. 97. Wooden Relay Box, L. S. & M. S.

ahead, as the track relay is at the leaving end of the section. Home control circuits are taken through instruments substantially as shown in normal clear circuits.

In all new work, home signals at mechanical interlocking plants are power operated. Typical control circuits are shown in Fig. 105. It will be noted that with everything normal, the operating apparatus at the signal is shunted on itself in order to afford protection against stray currents. Slotting is accomplished by providing a stick indicator to control the home signals so arranged that, once de-energized, it cannot again pick up until the signal lever has been put normal. Circuits for electric locking and the control of slotted mechanical signals are shown in Fig. 106.

Relays are of the neutral type and meet the specifications of the Railway Signal Association. Resistances are as follows: track, 4 ohms; crossover circuits, 16 ohms; line circuits, 1,000 ohms.

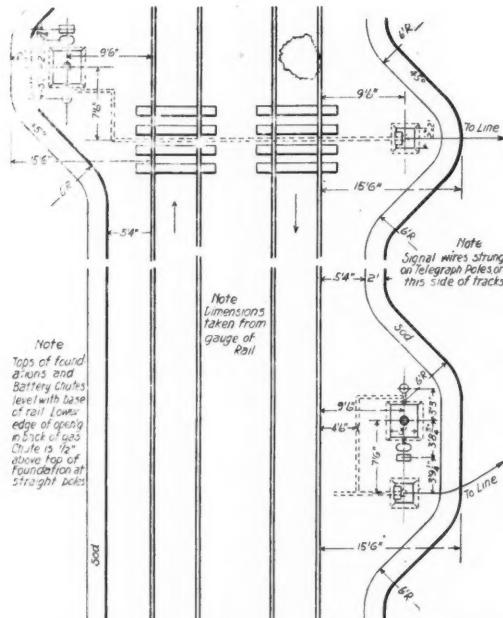


Fig. 92. Arrangements of Foundation and Other Apparatus, L. S. & M. S.

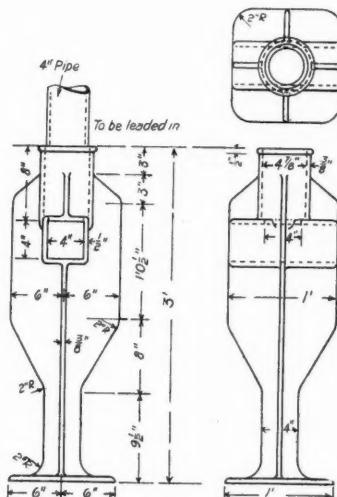


Fig. 90. Cast Iron Cable Post Foundation, L. S. & M. S.

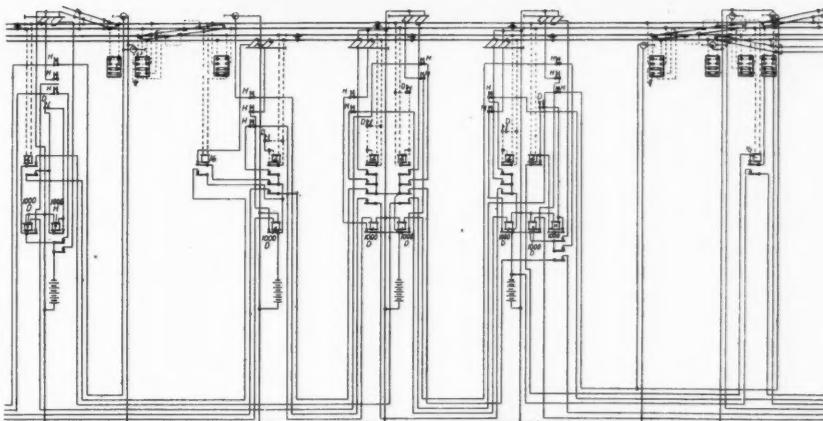


Fig. 103. Typical Control Circuits for Normal Clear Automatic Block Signals and Switch Indicators Without Line Relays, L. S. & M. S.

The following sizes and classes of wires are standard: For line circuits, No. 10, B. & S., gage hard drawn, weather proof copper; for bootlegs, No. 6, B. & S. gage, soft drawn rubber covered copper, and the same for leads from track and from battery to apparatus; leads from line to apparatus, No. 12, B. & S. gage, soft drawn, rubber covered copper and flexible wire of the same gage and class in chutes.

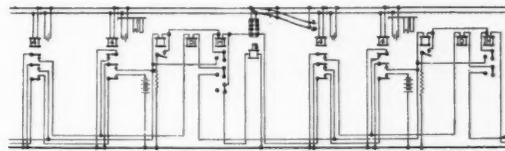


Fig. 104. Typical Control Circuits for Normal Danger Automatic Block Signals and Switch Indicators, L. S. & M. S.

The Maintenance of Way Department

Winter Maintenance

Editor Railway Engineering:—

Our method of maintaining tracks in winter is nearly the same every winter in this northeastern part of the country. It is very cold, with plenty of snow. The frost goes down deep in roadbed, causing it to move in places very unevenly, which requires a lot of surfacing and leveling up with shims. On some of the sections as many as 7,000 of these shims are used in one winter, ranging from one-quarter inch to three inches in thickness. Some places we have to put in cross ties and shim on top of these again to as much as eight inches altogether. A place like this has to be shimmed a number of times. Where shimming is done, we have it securely braced with wooden braces, using some of the shims for this purpose.

This shimming and handling snow takes up about all of the trackmen's time in winter. Of course there are bolts to tighten and sometimes spiking to gauge to do. Our force is the same in winter as in summer and after snowstorms we have to put on extra men to take care of snow.

Our crews are all English-speaking men, except a few French that learn to speak English in a short time. They all have to be watchful when there is so much shimming to be done.

Commencing in the spring we have to remove all of these shims again as the frost goes out, which is sometimes along in May. We can do no surfacing until the frost is all out.

Yours truly,
Maine.
Roadmaster.

namely, when shimming track in winter, when applying tie plates to hewed ties or when laying rail on ties that have been cut down somewhat.

We use chestnut, oak and cedar ties. The chestnut and oak are used under heavy traffic and on curves. The cedars are used on tangents. Tie plates are used quite extensively on both the cedar and the chestnut, but not on the oak.

Your truly,
Massachusetts.
Roadmaster.

No Adzing for Creosoted Ties

Editor Railway Engineering:—

It seems to me it ought to be very plain to every one that to adze a treated or creosoted tie you are defeating the object of this treatment as the creosote or other treatments that are given ties do not penetrate but from one-fourth to one-half inch from the surface of the tie and in adzing you cut not less than this and when you expose the inside of the tie by adzing away the treated part of it you are making it subject to rot in the usual length of time of an untreated tie and I don't know of anything that will prevent this decaying from spreading through the tie underneath the surface below the creosote.

In my opinion treated ties should not only not be adzed, but section men and others be prevented from putting a pick in them thereby making a hole and exposing the tie and starting it to decay.

Your truly,
Montana.
Roadmaster.

Adzing Creosoted Ties

ADZING CREOSOTED TIES.

Editor Railway Engineering:—

In regard to adzing creosoted and other treated ties, I see no reason why these ties should not be adzed when necessary just as much as any tie that is not treated; in fact I do not see how adzing can be avoided under certain conditions,

The Maintenance of Way Department

THE MAINTENANCE OF WAY DEPARTMENT.

Editor Railway Engineering:

It is not a good practice to adze creosoted timber. Creosoted ties should be prepared before treatment so it will not be

necessary to adze them. We use only one kind of tie, best white oak. When in wind they should be adzed to give the rail full bearing. Ties too much in wind should be condemned.

Roadmaster.
Tennessee.

Creosoted Ties

Editor Railway Engineering:

This company has never used any creosoted or other treated ties, and therefore I cannot speak from experience, but I think it would be a very bad practice to adze ties of this kind. We use only white and post oak ties and it is very seldom necessary to do any adzing except when applying continuous rail joints, or letting down a slight hump in track. While we frequently have zero weather in this section of the country, we are not bothered to any extent with heaving track, and I find that, if the necessary work is done in the spring and summer months, we can run track through the winter with very little work. My practice is to have a thorough smoothing up as soon as the weather will permit in the spring, and then all the renewing of ties and ballasting done as soon as possible, which leaves the fall months for ditching and cleaning right of way. I am not having any serious trouble with rough track on any portion of the 380 miles of track under my jurisdiction.

Roadmaster.
Tennessee.

Adzing Ties

Editor Railway Engineering:

I think the practice of adzing treated ties is very detrimental. I have noticed that in most ties, the penetration of the creosote or other ingredients is not very deep and in the application of tie plates it is necessary to adze a smooth surface on the face of the ties. With hewed ties I often find it necessary in surfacing for the reception of the tie plate or rail, to adze the tie more than an inch deep. This breaks the surface of the wood and often is deeper than the penetration. Therefore, the ties will take moisture and the adzed surface will rot very quickly as compared with the remainder of the tie. The sawed tie does not have to be adzed and it seems to me that sawed ties only should be treated. In fact, I think that such tie plates as have any corrugation, studs or spurs on the bottom are objectionable for the same reason, i. e., they break the surface of the tie and allow moisture to penetrate the fiber of the timber.

Roadmaster.
Oklahoma.

Adzing Creosoting Ties

Editor Railway Engineering:

We are not using creosoted ties, and I am unable, therefore, to give you any information from our own experience. I would like to submit below a few remarks, however, on the tie proposition as developed on our road. We have much heavy traffic, mostly sand, rock and fruit, also ten passenger trains per day. We use redwood ties and the Wolhaupler tie plate. We have many heavy curves and the rails turn very badly. This, of course, requires considerable regauging and adzing to bring the rails to a good bearing. While it is a bad feature to adze ties from time to time, I do not know of any other method to accomplish the desired results. A heavy plate would no doubt overcome our troubles to some extent, but with our heavy traffic we have to go over our 12 and 14 deg. curves once each year and do more or less adzing under both rails. Redwood ties will last 12 or 15 years in this soil, but under heavy traffic on heavy curves with light tie plates they cut and break in six or eight years; while on straight track we have redwood ties that have been in service 15 years and are in comparatively good condition. We have not had any success with hard pine. Such ties decay in four or five years, as do pine bridge timbers that are laid on the ground. We use redwood mud sills in

all our bridges and pine timbers where they will be clear of the ground.

Roadmaster.
California.

The Portable Storage Battery in Automatic Block Signal Service

Portable storage batteries have now been used in automatic block signal service for a sufficiently long period and on a sufficiently large scale, so that data based on actual results is available, and it is the purpose of this paper to bring together such data in convenient form for reference.

The regular use of storage batteries in this service dates from 1899. The first cells contained plates of the stationary type, assembled in portable form. They were not altogether satisfactory on account of their weight, two cells mounted in a case weighing about 60 pounds, and on this account, a few years later, a limited number of cells containing pasted plates of the vehicle type, were put in service. A pasted cell of equal capacity is much cheaper, smaller, lighter and consequently more portable. These cells known as the "PV-5," were not the proper shape, their base being too small for their height, so that they were easily upset, and on this account, a smaller plate approximately five inches square and known as the "SS" was adopted about 1904, and this plate is now the standard. The jars usually contain from seven to nine plates, according to the capacity required, and from four to six cells are commonly connected in series, depending upon the voltage of the signals. They are boxed in wooden carrying cases so that they are convenient for transportation. Table No. 1 shows the capacities, rates, dimensions and weights of different combinations.

Figure No. 2 shows a standard method of assembly and represents four cells, type "SS-9," contained in a single carrying case. Where it is desired to reduce the weight, two cells only are placed in a case. The early practice was to join the cells

No. of Cells in Case.	Type and No. of Plates.	Ampere Hour Capacity at Service Rate	Charging Rate in Amperes	Outside Diameter of Rubber Jars	Outside Dimensions of Case, in Inches			Weight in Pounds
					Length	Width	Height	
2	SS 5	40	4	6 3/4 inches long 5 1/8 inches wide 8 inches high	6 3/4	6 1/8	11 1/4	21
3	SS 5	40	4	8 1/2 inches long 6 1/8 inches wide 8 inches high	8 1/2	6 1/8	11 1/4	30
4	SS 5	40	4	10 7/8 inches long 7 1/8 inches wide 8 inches high	10 7/8	6 1/8	11 1/4	39 1/4
5	SS 5	40	4	12 1/8 inches long 8 1/8 inches wide 8 inches high	12 1/8	6 1/8	11 1/4	48 1/2
6	SS 5	40	4	15 inches long 9 1/8 inches wide 8 inches high	15	6 1/8	11 1/4	57
2	SS 7	60	6	8 1/4 inches long 5 1/8 inches wide 8 inches high	8 1/4	6 1/8	11 1/4	22 1/4
3	SS 7	60	6	10 7/8 inches long 6 1/8 inches wide 8 inches high	10 7/8	6 1/8	11 1/4	34 1/4
4	SS 7	60	6	13 7/8 inches long 7 1/8 inches wide 8 inches high	13 7/8	6 1/8	11 1/4	45 1/2
5	SS 7	60	6	16 1/8 inches long 8 1/8 inches wide 8 inches high	16 1/8	6 1/8	11 1/4	56 1/2
6	SS 7	60	6	20 7/8 inches long 9 1/8 inches wide 8 inches high	20 7/8	6 1/8	11 1/4	67
2	SS 9	80	8	9 5/8 inches long 5 1/8 inches wide 8 inches high	9 5/8	6 1/8	11 1/4	35 1/4
3	SS 9	80	8	12 1/8 inches long 6 1/8 inches wide 8 inches high	12 1/8	6 1/8	11 1/4	44
4	SS 9	80	8	16 1/8 inches long 7 1/8 inches wide 8 inches high	16 1/8	6 1/8	11 1/4	58 1/4
5	SS 9	80	8	20 3/8 inches long 8 1/8 inches wide 8 inches high	20 3/8	6 1/8	11 1/4	72 1/2
6	SS 9	80	8	24 1/8 inches long 9 1/8 inches wide 8 inches high	24 1/8	6 1/8	11 1/4	86
2	SS 11	100	10	11 5/8 inches high 5 1/8 inches long 8 inches wide	11 5/8	6 1/8	11 1/4	42 1/4
3	SS 11	100	10	16 1/8 inches high 6 1/8 inches long 8 inches wide	16 1/8	6 1/8	11 1/4	63
4	SS 11	100	10	20 7/8 inches high 7 1/8 inches long 8 inches wide	20 7/8	6 1/8	11 1/4	83 1/4
5	SS 11	100	10	25 7/8 inches high 8 1/8 inches long 8 inches wide	25 7/8	6 1/8	11 1/4	103 1/4
6	SS 11	100	10	30 1/8 inches high 9 1/8 inches long 8 inches wide	30 1/8	6 1/8	11 1/4	123

TABLE NO. I.

*By H. M. Beck, Electric Storage Battery Co., from Journal of the Railway Signal Association.

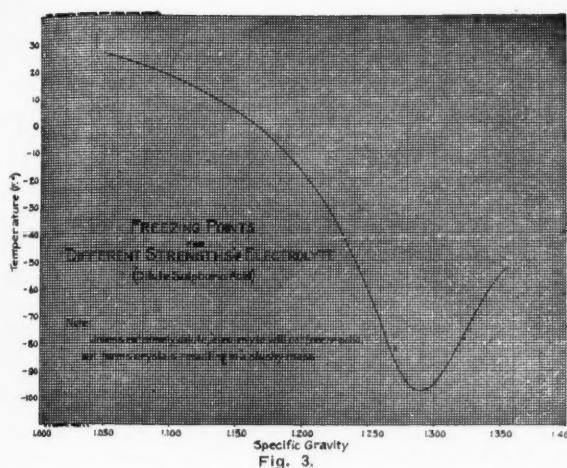


Fig. 3.

by some form of a clamp or bolt connector, so they could be easily taken apart, but experience has shown that with proper attention, it is seldom necessary to take them apart, so that the solid burned connection is coming into use. This practice, shown in the drawing, eliminates a number of connections which not only require considerable attention to keep them in good condition, but are also a possible source of failure. The end connection is brought down to a wing nut terminal by means of a flexible rubber covered cable. Thus in the assembly shown, the number of connections is reduced from eight to two.

As will be noted, the jars are set in compound. They are thus more uniformly supported, which means less breakage, and even should they break, the compound will tend to make the leak a slow one and to protect the wood from the action of the acid. The compound is carried up over the tops of the cells, covering everything but the vent plugs, and thus forms an effective sealing and prevents leakage. Drainage holes are provided which carry off any electrolyte which may collect on

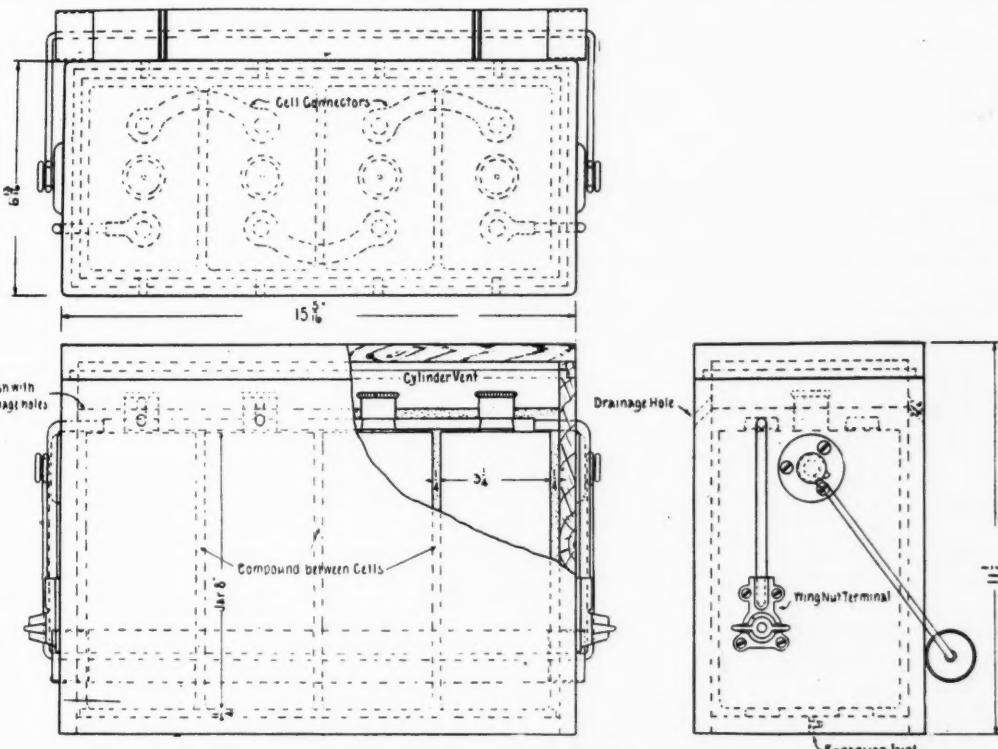
top of the compound. The cylinder vents are unscrewed when it is desired to replace the evaporation or take specific gravity readings of the electrolyte.

For spacing the plates, wooden separators have been found to be very satisfactory and are standard in practically all cases.

The wooden case is supplied with a cover for keeping out the dirt and the bottom contains an expansion joint, the purpose of which is to prevent the sides from being forced out, should the wood become acid soaked.

The number of cells in a set will depend upon the voltage of the signals and the speed at which it is desired to have them operate. It is usual to figure on two volts per cell, so that on this basis four cells would be required for an eight-volt signal. One large road is using four cells in connection with ten-volt signals, and reports that the duration of an operation is about ten seconds as against seven seconds, when sixteen primary cells are used. This refers to intermittent work, as where a number of operations follow each other in rapid succession, the storage battery gives the greater speed, due to its low internal resistance and high capacity. For equal speed on intermittent work, five cells of storage battery give about the same speed as sixteen primary cells.

The size of the cells or their ampere hour capacity will depend upon the number of signal operations and the length of time during which it is desired to have the battery operate without charging. At least one-third reserve capacity should be allowed for irregularities, or in case the battery is not charged promptly. It is usual to have a battery operate a signal for one month and then replace it, this period having been selected as the maximum during which it is safe to allow a battery to continue without charge. There are indications, however, that where it is of advantage and the capacity required is not too great, cells may be left out for periods of two months, and if properly charged, can be kept in good condition. Some experiments in this direction are now being made. On the other hand it will probably be found that, where the number of operations is so great that the cells have to be regularly changed more frequently than once in three weeks, the case is not a portable



Portable Cells for Signal Service.

battery situation. The number of operations which a given type of cell will give, has not been accurately determined, but in one case an "SS-9" was left out for three months without trouble, this corresponding to some 3,000 operations.

The number of sets of batteries required will depend upon a number of conditions and will have to be figured out for each particular case, as nothing more than the most general figures can be given. Due to the fact that a certain number of batteries will be required for charging while the rest are in use at the signals, there will always be a greater number of batteries than the number of battery locations. Some reserve sets will also be needed for overhauling and emergencies. Data obtained from several railroads indicates that the total number of extra sets required will be from 20 to 35 per cent of the actual number of battery locations.

Due to its high capacity and low internal resistance, it is practical to operate more than one signal from the same storage battery. One large railroad system has decided that it is economy to operate signals within 500 feet of each other from one battery. The number of battery locations as compared with the number of signal locations will vary in different cases as the number of signals which can be operated from a single battery will depend on their relative locations. Actual data obtained in one case shows the total number of batteries to be 86 per cent of the number of signal locations and 78 per cent of the total number of signal blades. In another the figures are 87 per cent and 83 per cent respectively.

Where portable storage batteries are used, facilities must be provided for charging. A separate building is not always necessary, as it is often possible to use part of a building required for other purposes, the space actually needed for charging the cells not being very great. For example, in one case where 225 sets of batteries are handled, the actual charging space is only about eight by twelve feet. Where storage batteries are not used it is still necessary to have some sort of a building for a store room, work shop, etc., and it has frequently been practical to use part of this or make a small addition to it. It is preferable to locate the charging plant at some place where reliable power can be purchased, rather than to attempt to install a generating outfit, as power can usually be purchased for less than it can be made. Small charging plants are apt to be unreliable and require a large percentage of the battery man's time to keep them running. It is also of considerable advantage to be able to charge over night, which is hardly practical in connection with small generating plants, as these need some one present to look after them. Lighting companies will generally give a very favorable rate on current for charging storage batteries on account of the character of the load. Figures obtained in widely different sections of the country show that such power can be purchased at from three to eight cents per KWH. If the power is alternating, a rectifier will be required, otherwise suitable resistances. In either case the switch board should include one voltmeter, an ammeter which can be connected in each circuit, if there is more than one, and for each circuit, a rheostat, an underload circuit breaker and the necessary switches and fuses. The rheostat should be capable of cutting down the voltage if necessary, so that it is practical to charge as few as three or four sets in series. The usual practice is to charge from six to ten sets in series, depending upon the number of cells per set. Forty individual cells can be charged from a 110-volt circuit. The number of circuits required will depend on the number of sets to be charged at any one time. The cost of a rectifier or direct current switch board while considerable in itself, does not amount to very much when divided among the two or three hundred sets of cells which it is capable of handling.

Where it is necessary to install a charging plant, from two to three KW capacity will usually be required.

With the storage battery system, a special battery man is required to look after the charging of the storage batteries, etc.

for each section of from 100 to 150 miles, but on the other hand, no other battery men are required and the maintainers not having to be battery men, are thus relieved of both responsibility and work, so that they can either cover more miles of track or else do work in other directions. For example, it is the regular practice where the storage battery is in use, for the maintainers to look after the lamps and no special lamp men are required. Thus, while with the storage battery system, an extra man is required to look after the batteries, this is compensated for by the fact that less men are needed on the road. Actual figures as to the total amount of labor under the supervisor have been obtained in several instances where the storage battery is used, and these are quite uniform where the conditions are comparable, showing an average of one man per ten miles of single track equipped with twenty signals. In considering these figures it should be borne in mind that they cover all labor, including foremen, repair men, lamp men, etc., and do not simply refer to the maintainers.

There are now a number of roads which have had portable storage batteries in use for five years or more and the results obtained under normal conditions, indicate that a depreciation of 20 per cent per year, is, if anything, conservative. There have been some special conditions in the extreme South under abnormally high temperatures, where plates have had to be renewed after only two years, but this condition is a special one and steps are being taken to meet it. Elsewhere the positives are giving from four to six years, while the negatives give indications of lasting much longer. This life is, if anything, less than might be expected, as it corresponds to only some sixty discharges on the basis of twelve per year, whereas the same type of plates will give some 200 discharges in a vehicle or 300 to 400 discharges on a bench. The shorter life in signal service is probably due to the cells not having as careful handling, or else to the long time over which the discharge work is distributed. The wooden carrying cases require renewal every two or three years, but this is a comparatively small item, while the rubber jars, except where broken, should last indefinitely. Thus a maintenance charge of 20 per cent per year on the first cost of battery would seem to be conservative.

Where power can be purchased, the cost of current for charging is surprisingly low. For example, consider a set of five cells, type "SS-9." Eight such sets can be charged in series from a 110-volt circuit. The charging rate is eight amperes and an average length of charge is probably about twenty hours. This corresponds to a very low ampere hour efficiency, only 40 per cent, but the efficiency in this service is low due to the infrequency of charging. At a price of six cents per KWH, the cost of charging the set would be

$$\begin{array}{r} 110 \times 8 \times 20 \times 6 \\ \hline = \$.132 \end{array}$$

8

Asuming twelve charges per year, this would amount to only \$1.59 per set per year.

A number of different schemes are being employed in transporting the cells to and from the signals and it is of course evident that the best solution in any case will depend somewhat on the local conditions. On one point, however, all seem to agree, namely, that the batteries should always be accompanied by an attendant in order to avoid damage in transit.

The most common method is to ship the cells to and from the maintainer's locations on local freight or passenger trains, and the maintainers then distribute them to the signals on gasoline cars or velocipedes. Either the battery man or an attendant accompanies each shipment. A modification of this system is to have the maintainers bring the batteries to the charging station. This scheme is being used by a road where the distances are not great and the train service frequent. Still another modification is to send the batteries out on local freights with sufficient men so that they can be exchanged at the signals as they are passed, without stopping the train. Four

men are needed. One jumps off the front of the train and disconnects the old battery from the signal. A few cars back two men get off with a charged battery which they put in place and return the discharged set to the train. The new battery is then connected up to the signal and the battery well closed before the rear of the train has come up.

A radically different scheme is being tried out by one of the Western roads, and the signal engineer is said to be very enthusiastic over it. A box car has been fitted up with a portable charging plant and is moved from point to point, stopping at the various maintainer's locations and charging the batteries. The crew consists of one man and as this car is able to cover 200 miles of track per month, it not only takes care of the transportation problem, but since two stationary plants would be required to handle the same territory, it cuts the number of charging plants and battery men in two.

The Missouri Pacific has had a system in operation for a number of years which has given excellent results, and as Mr. Mann has very kindly furnished complete information, it would probably be of interest to go somewhat into detail. The territory covered roughly forms a "Y" with St. Louis at the base. The battery house is located in the yards at St. Louis, current being supplied directly from the company shops. There is one battery man who takes entire care of the cells, charging, overhauling and delivering them to the maintainers at the local stations. Twice a week on Tuesdays and Fridays he goes out with charged batteries and delivers them at the local stations as previously requested by the maintainers. The batteries are then distributed to the signals by the maintainers on velocipedes, the discharged batteries being left at the most convenient station to be picked up by the battery man on his return. These trips require one day each. On the two intervening days the batteries are charged and overhauled. The train on which the batteries are shipped is in the yards over night and the batteries are loaded into the baggage car late in the afternoon or evening and go out the next morning. On the longest trip thirty sets of cells are taken out and the cells are delivered as far as Bismarck, a distance of seventy-nine miles. Batteries are required some twenty miles beyond this, but are carried on by relay, it not being practical for the battery man to go further and return to St. Louis the same night. With this system one man takes care of 225 sets of batteries, 36 of which constitute a reserve for repairs and charging.

As will be seen, the Missouri Pacific system combines a number of very excellent features. Power is furnished day and night so that the battery man is not only relieved of all responsibility in operating the generating plant, and thus has more time for the batteries, but the charge can go on through the night when he is absent, which results in a very considerable saving of time. Since the batteries are always under his supervision until delivered at the way stations, the likelihood of their being damaged is lessened.

The radius covered, seventy-nine miles, also indicates that this system ought to be quite generally applicable, as with charging stations only needed every 150 miles, it would seem like an exceptional case where reliable power could not be obtained within these limits, either from a public lighting or traction company or from a plant run in connection with some railroad pumping station or shops.

The effect of the use of portable storage batteries on the reliability of a signal system is a very difficult thing to determine. One of the largest users states that while their experience has been that there is also an economy, still their policy is entirely determined by the question of reliability and that the net result of the use of the storage battery is a lessened number of signal failures.

From a theoretical standpoint it seems as if there should be a tendency towards greater reliability. The more units there are in a battery, the more chance of trouble both in the

cells themselves and in the connections, as anything wrong with any one of them will interfere with all. The storage battery certainly reduces the number of units to a minimum. The maintainers do not have to be battery men, all that is required of them being to change the batteries at regular intervals. Battery knowledge is concentrated in one man who can be a specialist, and the batteries should thus receive average attention.

While at the higher rates of discharge their capacity is reduced at low temperatures, the temperature coefficient falls quite rapidly as the rates of discharge decrease, or what amounts to practically the same thing, the length of time during which the discharge takes place, increases. Thus while at an eight hour discharge rate the capacity decreases approximately one-half per cent. per degree Fahrenheit, at one-tenth of the eight hour rate the coefficient is only .15 per cent per degree Fahrenheit, or, in other words, the reduction in capacity is almost negligible.

The electrolyte is practically immune from freezing, so that no special precautions have to be taken in this direction. Figure No. 3 shows the points at which different strengths of electrolyte freeze and since the standard maximum gravity for signal cells is 1.280 to 1.300, it will be noted that there is almost a negligible quantity.

From the standpoint of economy also the storage battery would seem to be an excellent proposition. The initial cost of the cells can easily be obtained from the makers and with the data here given, both the approximate total first cost and maintenance expense for a given case can be quite easily worked out and it is believed that many cases will be found where a marked saving could be made.

In closing there are one or two points which should not be overlooked. First, portable storage batteries have now been used in signal service on a considerable scale for some ten years, so they can no longer be considered as an experiment. Second, in the last ten years conditions have changed very materially in regard to the possibility of purchasing reliable power for charging. Small towns all over the country now have their own lighting plants, electric railways are springing up everywhere, and thus the problem of charging has been greatly simplified, so that while the portable storage battery has its limitations, it certainly seems well worthy of serious investigation in many cases where it is not now being considered.

Soda-Copper Oxide Primary Cell on Track Circuits

By Mr. E. L. Marshall, National Carbon Company.

CURRENT DRAIN.

The drain upon a battery depends upon three factors:

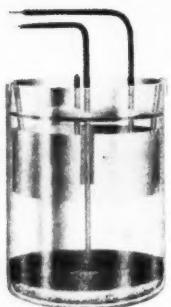
- Continuous drain through rails and relay.
- Shunt drain when train is in the block.
- Leakage.

(a) The continuous drain in ideal track circuits of given lengths with 4-ohm relays, where there are no losses due to leakage, should be approximately as given below. These are theoretical values, but serve to indicate how much current is necessary to operate the relay, and also to suggest how large a proportion of the usual drain is wasted in leakage.

- 1,000 foot circuits 173 milli-ampere.
- 2,000 foot circuits 163 milli-ampere.
- 3,000 foot circuits 152 milli-ampere.
- 4,000 foot circuits 143 milli-ampere.
- 5,000 foot circuits 134 milli-ampere.

(b) Shunt drain when train is in the block. In order to demonstrate the effect that any given number of trains will have on the life of a battery, we shall use the equation below,

*From the Journal of the Railway Signal Association.



Soda-Copper Oxide Cells. National Carbon Co.

obtaining the answer in number of days that a battery of two cells in parallel will last under certain conditions.

These conditions are:

$$\text{Capacity} = \text{Ampere hour rating of cell } 2 \times 350 = 700$$

$$a = \text{Number of train movements} = 30$$

$$b = \text{Time of train in block in minutes} = 2$$

$$c = \text{Drain in amperes, block clear} = .300$$

$$d = \text{Drain in amperes, train in block} = .80$$

Then No. days =

$$\frac{\text{Capacity}}{\left\{ \frac{a \times b}{60} \right\} c + \frac{a \times b \times d}{60}} = \frac{700}{\left\{ \frac{24}{60} - \frac{30 \times 2}{60} \right\} .3 + \frac{30 \times 2 \times .8}{60}} = 91 \text{ days}$$

Substituting the various values given in the table below we obtain the results in the last column.

Example	Trains per 24 hours	Time of train in block in minutes	Drain with train in block in amperes	Drain in open block in amperes	Days life of battery
1	30	2	.8	.16	156
2	30	2	.8	.25	107
3	30	22	.8	.30	91
4	30	3	.8	.30	88
5	30	5	.8	.30	83
6	40	2	.8	.30	90
7	60	2	.8	.30	85

Example 3 corresponds approximately to average conditions. Comparing examples 3 and 5 we note that an increase of three minutes in length of time each train is in the block shortens the service life 8 days. This is greater than the effect of doubling the number of trains per day, as is seen by comparing examples 4 and 7, which shortens the service life but 6 days.

(e) Leakage.—Leakage of current is the cause of high drain when the block is clear, and this leakage is increased by bad conditions, such as:

Ballast in contact with the rails,

Grounded rails,

Ties saturated with brine,

Switches.

Ballast in contact with rails is the chief cause of low insulation resistance. Where tracks are not properly drained, water being allowed to collect between the rails, the leakage is very high and signal failures are liable to result.

By grounded rails we mean the use of any kind of "anti-creeper" that extends from the rail down into the ballast, thus making good contact with the earth. The leakage which this causes is very serious.

Ties saturated with brine.—The conductivity of brine in the ties is very high, and is sufficient at times to bring the insulation resistance below 2.0 ohms.

Switches cause more or less leakage because of the difficulty of properly insulating them.

In order to understand how important a factor leakage is, let us apply our formula. Referring to the table of service life data given below, we see that the leakage of current in a track circuit is by far the most important factor. Compare examples 1 and 3. With an average drain of .16 ampere, which means practically no loss of leakage, the battery would last 156 days,

or 5 months, while but 3 months life can be obtained when leakage brings up the drain to .3 ampere. By improving track conditions, and thereby cutting the leakage and reducing the drain in open block to .25 (see example 2), we obtain a life of 107 days, or a gain of over two weeks in life. The decrease in drain is slight, but the increase in life is quite appreciable.

The battery which track circuit conditions require is one that can deliver a constant current without polarizing rapidly. The gravity cell has been used almost exclusively on track circuits until within the last few years. As the gravity cell is too well known to need description, we shall consider now the soda-copper oxide cell.

Soda-Copper Oxide Cells.—There have been three types of soda-copper oxide cells.

First Type.—The first type had low internal resistance. Since this cell was designed for gas engine ignition and for operating automatic block signals, it had a high current discharge, and consequently an external resistance had to be inserted to prevent excessive drain when the cells were employed on track circuits.

Second Type.—This cell had a high internal resistance due to the shape and position of its elements, and to the insertion of a porcelain grid between them. This cell has given good service on track circuits, but because of its greater cost it could not compete with the gravity cell. Like all other soda cells then in use, it had the disadvantage of not giving any evidence as to when it was nearly exhausted, there being no visible end-point or any means of testing for it.

Third Type.—A glass jar, preferably of heat resisting glass, warranted not to break with sudden changes of temperature, is used. The electrolyte is a strong caustic soda solution. On the bottom of the jar within the solution is placed a circular tin plate, having an insulated copper wire riveted to its center, serving as positive terminal. The positive element, which is fine, flaky copper oxide, is poured into the solution. This material settles rapidly to the bottom upon the plate which serves as the current collector. The negative element is a narrow circular zinc, supported just under the surface of the solution by three supporting wires hooked over the edge of the jar. The oil poured over the soda solution after the cell is set up protects the solution from the action of the air. This arrangement of the parts produces high internal resistance; and the construction of the cell is such that maximum efficiency is obtained.

The capacity of this cell is 350 ampere hours.

After the cell has been in service a few weeks, one can see that the black copper oxide next to the tin disc has turned red; as time goes on this red area increases in size until it covers the entire visible vertical surface of the positive element. When all black disappeared, the battery man knows that the batteries should be renewed.

To sum up the points of superiority of this type we have:

- (1) Visible indicator of condition.
- (2) High internal resistance removing the necessity for any external resistance.
- (3) Simplicity of construction.
- (4) Lower cost, especially of renewals.

Another advantage of this type of cell is its freedom from serious effects due to low temperature. This cell does not freeze, and unlike soda cells of other types does not even congeal. Thirty-five degrees below zero has been known to have no serious effect upon its efficiency in service. This feature indicates the possibility of saving, no cast iron chutes or battery wells, for housing the track batteries below frost line being needed.

In warm weather a gravity cell loses solution by evaporation. The soda cell suffers no such loss, and hence requires no addition of water after once set up.

The working voltage of a gravity cell is from .10 to .15 of a

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volt higher than that of the soda cell, a feature in favor of the latter; for while the amount of current is less with the soda cell, it is sufficient for all conditions, and the lower internal resistance makes it pick up more rapidly than the gravity. A very severe test of a soda battery was a case where a train stood in the block three-quarters of an hour, but when the train left the block the relay picked up immediately, a performance that will equal that of any gravity cell.

Where two cells of gravity were used in parallel, two soda cells in parallel must be used on the same circuit.

Service.—The length of service life of these cells depends upon the conditions of the track circuits upon which they are employed. In actual practice it has been found to vary from 90 to 180 days, the former case being that of an automatic block circuit with heavy traffic, the latter that of an isolated crossing bell track circuit where traffic was comparatively light. The average life has been found to be about 130 days, or over 4 months. One road using soda cells has obtained an average service life of 143 days, computed from 65 different tests.

If we take the average value of 130 days, we find that this means only 2.8 renewals per year. If we assume that gravity cells must have "blue stone" added every three weeks and have the zinc cleaned once a week, we can realize the possibility of saving labor by the use of the soda cell. The battery man does not have to clean or replenish this cell until it is completely exhausted, and by merely observing the extent of the reduction of the black copper oxide to red copper he can tell whether renewal is necessary or not. While in some cases the amount of labor for the battery man might not be decreased because track battery inspection is but a small part of his work, it must ultimately bring about some saving of time as all improvements do. One type of service where the saving will be most marked is that of crossing bell circuits, which are situated in remote localities and require battery men to travel considerable distances to inspect and renew the batteries.

Cost.—For installation the cost will be:

Gravity complete with ordinary glass jar.....	\$.74
Gravity complete with heat resisting glass jar.....	1.25
Soda cell complete with heat resisting glass jar....	1.54

The expense of renewals depends upon the length of life of the respective cells, or upon the number of renewals of each per year. One road, which has used an earlier type of soda cell, not the improved type above described, has figured its yearly cost as follows:

Gravity cells, per year.....	\$3.46
Soda cells, per year.....	2.77

Saving, per cell, per year, by use of soda cells... \$0.69

If we assume for gravity two pounds renewals of "blue stone" every three weeks and three new zines per year, and for the soda cell 130 days' service for each renewal, the yearly renewal cost will be as follows:

Gravity, 35 lbs. "blue stone" and 3 4-lb. 2% mer-	
cury zines	\$3.24
Soda cell, 2.8 renewals at \$0.81 per renewal.....	2.27

Saving, per year, per cell, by the use of soda cell.\$0.97

Had the road above quoted used the improved type of cell instead of the earlier model, it would have made a greater saving than \$0.69 per cell per year, because of the lower cost of and the longer life obtained from renewals for the improved soda cell.

Lightning Protection

By Mr. Otto Holstein, Chief Train Dispatcher, Central Railway of Peru.

Having had a number of years experience in the Southern States and Western States and Territories in the United States, in the Philippine Islands, on the Isthmus of Panama, in Peru, and on ships at sea, my experience with electrical storms and the protection of wires and apparatus from their effects may be of interest to some of the members of the Association.

From my observation in these widely-separated parts of the world, I can say that no where have I encountered electrical storms of such magnitude as those of the higher altitudes of the cordillera of the Andes. It is very probable that in the Rocky Mountains of our own country, as well as in many other parts of the world, where altitude, temperature, latitude or geological formation, or whatever it is, that bears the most important relation to the phenomena in question, are as favorable as here, electrical storms of equal proportions will be encountered.

The country on the western or Pacific Slope of the Peruvian Andes is dry and barren, very much like our Mojave Desert in California and Arizona. Above the altitude of 10,000 feet, rain, snow and electrical storms are frequent and very violent, although usually of short duration during the summer. On the high peaks and in the passes, and through the higher altitudes the storms, generally, both rain, snow and electrical, are of the greatest violence.

Electrical storms come with almost no warning. I found the telephone a good warner of a coming storm, the "howler" would give notice of the presence of static electricity long before any sign was visible to the eye.

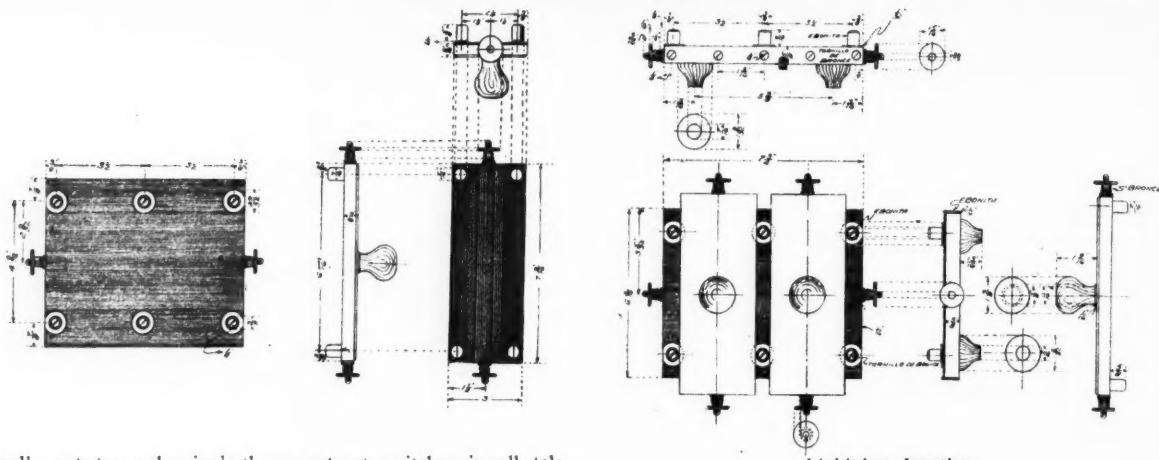
The clouds seem to collect from nowhere, around some peak, and in a very few minutes the vicinity of the peak was ablaze in a terrific electrical storm.

Although electrical storms frequently come alone, they more often accompany heavy snowstorms, often coming after it has been snowing quietly for a good half hour or so, and, after from fifteen minutes to half hour of blinding flashes and pealing thunder, disappear as suddenly as it has come.

The peaks are rich in mineral and probably offer a better conductor than frozen pampa covered with comparatively dry snow. I have noticed among the peaks static appears to be disposed of with greater facility than on the pampa where it plays more pranks before finally disappearing.

A lightning arrester, known as the "Argus", is used on the Cerro de Pasco line, for the protection of telegraph and telephone apparatus and also for the protection of the train staff machines. In the case of the telegraph, these arresters have done excellent work. During one storm the lightning arrester was completely destroyed by a heavy discharge while the telegraph relay was not damaged. During another storm on the same road, the helix of the arrester was fused, but no damage was suffered by the telegraph apparatus. The results obtained in the case of the telephones were not so gratifying as in the case of the telegraph apparatus, for, although the current that got through the arrester before it reached an intensity sufficient to break down the resistance of the air gap between the helix and the ground plate, and was not sufficient to cause any damage to the telegraph relays, it was sufficient to puncture the comparatively delicate oiled-paper tinfoil condensers used to bridge telegraph instruments in intermediate offices and in telephone circuits where these instruments were installed. The condensers in way stations gave us a great deal of trouble and after a storm if a telegraph station did not answer after some hours of calling, it was almost certain the office had been cut out by a short-circuited condenser. We

*From the Journal of the Railway Signal Association.



Lightning Arrester.

finally put two-pole single-throw cut-out switches in all telephone circuits as well as in condenser circuits at intermediate offices, with instructions to open switches on first appearance of a storm.

As stated in the case of the telegraph, the Argus arrester gave excellent results, and I have in my possession at the present time, three arresters that have been all but completely destroyed by lightning discharges.

On the Central I found a type of lightning arrester that was entirely new to me, and as I have never met with it before, it may be new also to some of the members of the association. The arrester in question embodies many good features, and its performance has been so satisfactory on this road that I consider it worthy of some further description.

The principal parts of this arrester are of cast iron, the arrester shown in the accompanying diagram is of the two-line type.

The diagram shows the ground plate with the two-line plates removed; these latter are shown at either side of the ground plate. The ground plate measures $7\frac{3}{4}$ in. by $6\frac{1}{8}$ in. and stands on four legs cast with the plate. The whole upper surface of this plate is furrowed and sharply ridged, as shown in the profile of the ground plate on the left. The line plates are likewise furrowed, as shown in the upper right-hand diagram. The arrester, when assembled, as shown in the figure at the left, has these sharp ridges at right angles, making every point of intersection (of which there are thousands) a spark-gap with an air-space or but $\frac{1}{2}$ in. to break down. As can be seen, thousands of small spark-gaps in multiple with but $\frac{1}{2}$ in. of air resistance to break down, impose but a negligible resistance to a static discharge of any intensity. The line plates and ground plate are separated by hard-rubber or ebonite washers $\frac{1}{2}$ in. in thickness and the line plates are held in position by sentinels of the same material which are secured to the ground plate and which clamp the washers in position. On the line plates brass lugs are secured which also serve to hold the line plates in position; these lugs are insulated from the ground plate by a strip of ebonite that extends along the sides of this plate. As can be seen, the plates to which the line is connected can be lifted from the ground plate for inspection or for cleaning without interfering with the working of the wires. The only fault that can be found with these arresters is that it is rather heavy, the weight of the two-line type being about fifteen pounds.

The records of this road show excellent performance for this type of lightning arrester. There are records of some violent storms where office and ground leads have been fused by static electricity but no instruments have been lost.

The original manner of connecting the arresters was to connect them in series with the line and instruments and, inasmuch as they appear to have done their work so connected, it

might seem best to let well enough alone, but I have put choke coils in series with the line plates of the arresters and the instruments with a view of still further retarding the passage of the high frequency discharge causing the charge to bank up and break down the resistance of the arrester sooner than it would otherwise, thereby offering greater protection to the instruments. Good ground leads have also been sought and both binding posts of the ground plate have been connected with separate grounds. A flat copper ribbon being used for the ground conductor, this form of conductor appears to embody qualities not possessed by round conductors. As may be supposed, I am awaiting the result of these changes and as our summer is not far off, I hope to be able to report still further on the subject.

Result of Letter Ballots

The executive committee announced that all the propositions submitted to letter ballot, at the annual meeting, held in Louisville, Ky., have been adopted as recommended standards by this association, with the exception of the report of committee No. 1 on Signaling Practice, all, with this exception, having received more than the required two-thirds affirmative vote.

The subjects voted upon were as follows:

Specifications for Mechanical Interlocking.

Specifications for Electric Interlocking.

Specifications for Automatic Block Signals operated by direct current for Steam Railroads.

Storage Battery Jars and Accessories.

Specifications—Wires and Cables. Items as follows:

Steel Signal Wire Galvanized.

Taping and Braiding, correcting 1908 Specifications.

Stranding Table, correcting 1908 Specifications.

Subjects and Definitions, defining the following terms:

Operated Unit—A switch, signal, lock or other device in signaling, operated by a lever or other operating means.

Semaphore Spectacle—That part of the signal which holds the colored glasses and to which the blade may be attached.

Mast—The upright to which the signals are directly attached.

Bracket Mast—A mast mounted on a bracket post.

Bridge Mast—A mast mounted on a signal or other overhead bridge.

Bracket Post—The principle supporting upright of a bracket signal structure.

Farmers' Instruction Trains

Arrangements were completed by the Pennsylvania Railroad to operate a farmers' special instruction train in southern New Jersey on March 10, 11 and 12. The railroad is co-operating

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in this movement with the state Board of Agriculture and the State Agricultural College of New Jersey.

Some twelve farmers' special instruction trains have been operated on various parts of the railroad during the year. The railroad's agents have been made missionaries in the cause of good farming; some 50,000 copies of pamphlets on alfalfa, use of lime on land, and on orchard development have been distributed, and, in addition, the company has become prominently identified with the good roads movement in the states through which it operates.

During the three days' tour which was made by the New Jersey farmers' special, stops were made at seventeen stations, at each of which four lectures were given. The subjects of the lectures were "Production of Corn," "Production of White Potatoes," "Production of Sweet Potatoes," "Production of Alfalfa," "Soil Improvement," "Uses of Lime," "Uses of Fertilizers," "Uses of Manures," "Dairy Farming," "Poultry and Eggs," "Spray Mixtures," "Growing and Marketing Fruit," and "Market Gardening."

Representing the New Jersey state Agricultural College and Experiment Station were Dr. Edward B. Voorhees, Edward VanAlstyne, Professor K. C. Davis, M. A. Blake, and F. C. Minkler, J. H. Wolseiffer, and Charles Chambers. Superintendents J. T. Wailis and Victor Wierman, and Division Freight Agents William Coffin and W. W. Wimer represented the Pennsylvania Railroad.

The United States Forest Service

We publish below information relative to the national forests supplied by the Department of Agriculture:

Squatter Rights on National Forests Recognized.

Secretary Wilson has just issued an order providing for a more liberal treatment of bona fide squatters upon unsurveyed land which has been included within National Forests since the time of actual occupancy of the land by the squatter.

"Under the homestead law it is impossible for any one to secure legal title to unsurveyed public land, but occupancy pending survey is recognized as giving a prior claim to the land after survey, under what is known as 'squatter's rights.' A squatter who had, in good faith, taken possession of a piece of national forest land before the national forests were created is not dispossessed of his claim by the Forest Service, and if he lives upon it and cultivates it until the land has been surveyed, he is able to get his homestead just as though he had settled on any part of the unreserved public domain. But since the passage of the Act of June 11, 1906, which permits the Secretary of Agriculture to list for settlement land which he finds chiefly valuable for agriculture, it has been possible for squatters to apply for the listing of their lands under this act, and thus to obtain title prior to government survey. The object of the new order of the secretary is to provide for the listing of the full amount of land which the occupant would receive if he exercised his option of awaiting the government survey, irrespective of whether or not the entire area is cultivable, provided the claim is bona fide and the land is not more valuable for its timber than for agriculture.

"Secretary Wilson's order is as follows: 'A person who has settled upon and continuously occupied unsurveyed lands within a national forest before its creation and is at the present time occupying such lands in good faith and is in all respects complying with the homestead law, has the right to include within the lines of his homestead 160 acres after the land is surveyed. Therefore, if the land is occupied for agricultural purposes and is not more valuable for its timber than for such purposes, and there are no circumstances which would in the opinion of the district forester tend to discredit the bona fides of the claimant, he should be allowed to make application for the patenting of such lands under the Act of June 11, 1906, and the examination for listing should be made with a view of listing 160 acres of land where possible. The tracts as listed should conform so far as practicable to the form of the public

land surveys. The listing of lands as above should not in any way govern the determination of the total area or amount of non-cultivable land listed for applicants under the Act of June 11, 1906, who were not residing upon the land before the creation of the forest.'

"In cases where less than 160 acres of land has been listed to a person who settled upon the land prior to the creation of the forest, an additional area sufficient to complete the home-stead entry may be allowed upon proper application."

Last Year's Forest Fires

"Fire played less havoc in the woodlands of the national forest states last year than it did in 1908, although the number of fires was 410 greater. The Department of Agriculture has just completed the statistics. The protective value of the work of the department is shown in that (1) almost 80 per cent of the fires were extinguished before as much as five acres had been damaged; (2) less than one and one-half acres to the square mile of national forest land was burned over; (3) the amount of damage done to the burned-over area averaged but \$1.26 per acre.

"For the year ended December 31 last, there were 3,138 fires in the forests, 1,186 caused by locomotives, 431 by campers, 294 by lightning, 181 by brush burning, 97 by incendiaries, 38 by sawmills and donkey engines, 153 by miscellaneous and 758 by unknown agencies. The area burned over was, in round figures, 360,000 acres, of which about 62,000 were private lands in national forests, as against some 400,000 acres in 1908. Some 170,000,000 board feet of timber was consumed, of which 33,000,000 feet was privately owned, as against 230,000,000 in the previous year. The loss in value of timber destroyed was less than \$300,000, of which close to \$50,000 was privately owned. The loss of the year before was about \$450,000. Damage done to reproduction and forage shows a remarkable decrease, less than \$160,000 being the record for 1909 and over \$700,000 that for 1908.

"The largest number of fires occurred in Idaho—991; but the great increase over 1908 in that state, namely, 573, is entirely attributed to fires in the Coeur d'Alene, which were extinguished without material damage. Locomotive sparks were accountable for 611 of the blazes in this forest last year. The explanation of the increase in the total for all forests is to be found in this Coeur d'Alene increase.

"The report of the forester for 1909 said of the fire record of 1908: 'That year was one of prolonged drought during the summer and fall, and of disastrous forest fires throughout the country. The national forests suffered relatively little. . . . About 232,191,000 board feet of timber, or 0.06 per cent of the stand, was destroyed. . . . A total of 2,728 fires was reported, of which 2,089 were small fires confined as a rule to an area of five acres or less. The cost of fire fighting, exclusive of the salaries of forest officers, was \$73,283.33. This sum, added to the proportion of the total salaries of rangers and guards properly chargeable to patrol and fire fighting, was less than one-twentieth of one per cent of the value of the timber protected estimated at an average stumpage value of \$2 per thousand.'

Annual Dinner of The Maintenance of Way Association

The annual dinner was held in the Gold Room of the Congress Hotel, Chicago, Wednesday evening, March 16th, 304 people being seated at the tables and many ladies occupied the gallery. During the dinner entertainment was furnished by orchestral music, recitations and singing, in which all joined.

President McNab, toastmaster, displayed his well-known humor in his address of introduction. The first speaker was Hon. Geo. P. Graham, Minister of Railways and Canals of the Dominion of Canada. He spoke of the relations of Canada and the United States, deprecating talk of the threatened tariff war and showing how disastrous such an event would be. He cited statistics of trade and railways in the Dominion, showing what

wonderful progress had been made of late years. He mentioned the present tide of emigration from the United States to the wheat fields of the northwest, speaking highly of the character of the people who are settling there. His concluding remarks were as follows:

"Now, as to the great waterways of the Dominion of Canada and the United States in common—this perhaps has not impressed itself upon you, who are along the Great Lakes in this section—but Canada owns the gateway of the St. Lawrence.

"Then, sir, we have our great canals. You have your canals; we have nineteen. We are going to have more in a few years. I will not at all discuss with you the advisability of enlarging the Welland canal; that is one of the things that will be done in a few years, so that the five hundred and more great lake vessels that now have to stop at Port Colbourne and unload will be able to go through the Welland canal down at least through the lakes to the head of what is known as the St. Lawrence canal. When the Welland canal is deepened, wheat can be carried from Duluth to Montreal, forwarders tell me at a fair profit at three and a half or three and five-eighths cents per bushel. What is known as the Georgian Bay canal project is now before the people not only of Canada, but of all the world. That canal, of course, would connect the Georgian Bay at Lake Huron with Montreal, where there is a deep ship channel going out to sea. It would save a good many miles even over the Welland canal and the Great Lakes route.

"The government is beginning this year to start the construction of the Hudson Bay Railway; that is, a railway from the center of the wheat belt of our great west to Hudson Bay. It will not only afford a splendid means of transportation for the grain products, but it will give an advantageous route for the stock of the great western lands to be carried to the markets of the old country with a very short railway haul and a cool route as long as navigation is open, which is a great advantage in the transportation of stock.

"Now, as to the Quebec Bridge project. The Anglo-Saxon race never knows defeat; what they undertake they generally accomplish; and the government of Canada has taken over that project from the Quebec Bridge Company and has placed it in the Department of Railways and Canals. When the government took over this project, I suggested—and they adopted it—the formation of a board of engineers, prominent bridge engineers, to whom would be given full authority to make the plans, and to see that the bridge was constructed under the plans, so that if there is failure we would know where the failure ought to be placed. Mr. Fitz Maurice, the chief engineer of the County Council of London, England; Mr. Votely, of Montreal, and last, but by no means the least efficient and able member of that board, is Mr. Modjeska, of the city of Chicago. The span of this bridge will be nearly 800 ft.; the width 88 ft., and it is designed to carry two double steam railway tracks, two electric lines, two roadways, as well as accommodations for foot passengers. You are engaged in a great work; so are we. Our relations are most cordial; they ought to always be. If you will allow me in the words of a very crude couplet, which some of you may recognize, though slightly modified, I will express the feelings we have in Canada towards you:

"Dear Samuel, we like you; yes, we do;

"We are proud of your gentle touch;

"But we cannot leave Mother, not even for you;

"She is so kind and we love her too much."

The second speaker was Mr. Ralph M. Shaw, attorney, of Chicago. Mr. Shaw spoke of the relations of railroads to the government. He traced government regulation of interstate commerce from the time New York granted to Robert Fulton a monopoly of navigation of the Hudson river to the present time, showing that whereas restrictions upon the operation and management of railways have multiplied without ceasing, yet the railways have gained little or nothing in return, being not even protected from the acts of their employees.

"We search the statute books and laws of Congress in vain for a single federal enactment which has been devised and passed for the benefit of the railway companies. For the farmers who may buy land, work it and sell it as they please and charge such prices as they can get; for the manufacturers who may earn unlimited sums upon the capital invested, the Congress of the United States has passed a protective tariff. For the railways it has enacted laws which tend to diminish profits.

"While for the purpose of complying with the laws, millions have been spent by the companies for improvements in equipment, etc., not one law has ever been passed by the Federal government aimed at fixing individual responsibility for accidents. In Mexico, at whose laws and civilization we sometimes sneer, when an employee of a railway company, through his negligence, is responsible for an accident resulting in damage either to person or property, he is punished promptly by the state. There are similar laws in England and Canada.

"During the past few years one of the great systems in this country has spent more than five million dollars in installing along the entire line of its road the most modern safety and signal appliances which human science has yet been able to devise. Within a year four bad wrecks have occurred on the line of this road, resulting in enormous loss of life and property, caused by the neglect of the train crews to recognize and follow rules and regulations established for their safety, and which, if observed, would have prevented the accidents. There is no law under which they may be punished. The railway is responsible for the accident and must pocket the loss and pay the damages.

"Under the Federal Safety Appliance Act it is not made a crime for an employee to couple up a defective car into a train, but it is made a crime for the company, who has no knowledge of the defect, to haul the car so coupled up, and use it for transportation purposes. The employees of the company are urged to report violations of the law to the employees of the government. In other words, the men who make the company violate the law, by refusing to report defective cars, or by coupling them into trains with knowledge of their defects, are encouraged by the government to report violations so made against the companies, who are substantially helpless in the matter.

"No greater injury could be done to the confidence and good-fellowship which ought to obtain between the companies and their employees than to create and promote such a system of espionage, by which those who violate the law and are by the law held blameless, become the witnesses in criminal cases against the companies, who are not responsible, morally, for the violation. It destroys discipline and creates hostility. It is an evil which, in justice to those who have the responsibility, but not the power, should be rectified by the government, which has the power and not the responsibility."

The next speaker was Dr. Judson, president of the University of Chicago.

Dr. Judson spoke briefly of the relations of the college and university graduate to the engineering profession and outlined the problems of technical education as they affect the university.

Dr. Judson was followed by Hon. Milton J. Foreman, member of the City Council of Chicago. Mr. Foreman spoke of the relations of the Chicago railways* to the city, particularly of electrification. He told of his endeavors to bring about a mitigation of the smoke nuisance and of the attitude of the railways thereto. His point of view was expressed as follows:

"If I were to talk about the relation of legislative bodies to railways, I would say that the relation is that of a

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mother-in-law, a kind and gentle mother-in-law, but one who is not sparing in her admonitions.

"Now, we, in Chicago, had some experience with railway engineers. We have discovered that they are a hardy race; their patience and faith outruns their work, so far as the city of Chicago is concerned. We have a faint, glimmering idea that some time we would like to have locomotives quit smoking—just a diaphanous day dream, gentlemen, born in the solitude of our legislative chamber. We consult the railway officials, and they say, 'Certainly; perfectly feasible, and we will refer it to our engineers, to show you how absolutely impossible it is.' (Laughter and applause.) If the engineering department of a railway is good for nothing else, it is good to show the utter futility of cities attempting to do anything they think they would like to do. They do not shock us, by telling us, brutally, that we cannot do it; they accommodately show us a series of blue prints, with wavy lines, and after we have seen these blue prints, series and tomes, and volumes and editions, they tell us it is absolutely certain now, that it can be done, but 'we have got to get out another set of blue prints to show you how impossible it is.' (Laughter and applause.) I applaud their patience and ingenuity. Of course, I do not think that everything is true that is said about them."

The last speaker of the evening, Mr. A. H. Rudd, Signal Engineer of the Pennsylvania R. R., and a director of the association, wisely devoted his time in the late evening to pointed humor and pertinent stories; closing by reading Kipling's poem, "The Sons of Martha," which was the subject of his address. He defined the "Sons of Martha" as the "Knights of the Tommey Bar, the Heroes of the Pick and Shovel, the men who work with their hands, and he told many humorous and witty stories, illustrating the lighter side of the work on the road.

The toastmaster called upon Mr. Howard Kelly, former president of the association, who offered a resolution of thanks to the Committee of Arrangements, for their admirable work. This was unanimously carried, and Mr. Frank R. Coates of the committee was called for and responded with an apt story, which closed the evening with a good laugh.

The Committee of Arrangements which has handled matters with great efficiency and quietness is as follows:

W. A. Wallace, Chairman, Div. Eng. C. T. & L. Ry., Chicago.

J. B. Cox, Consulting Eng., Chicago.

J. C. Seser, Great Northern Ry., St. Paul, Minn.

F. R. Coates, vice-Pres. Interocean Steel Co., Chicago.

L. C. Fritch, Pres. A. R. E. & M. of W. Assn., Ch. Eng. C. Gt. W. R. R., Chicago.

O. J. West, Res. Eng. Phoenix Bridge Co., Chicago.

The President's Address.

At the close of the eleventh year of the existence of your association, it is gratifying to note that general progress and steady increase in activity have been manifested in every department of its work.

This progress is due not merely to additions in the association's membership and to the zeal of its officers, committees and individual members in promoting the objects for which it was formed, but it lies also in the possession of a greater degree of that direct influence in the practical railway world, which it has always been the aspiration of the association to maintain. Seldom before have greater or more important problems in transportation matters, where such influence can be an aid, come before railway managements

in general than at the present time, and these conditions must be apparent to every one who has kept pace with the improvements, as well as the methods of practice everywhere in evidence. More especially must they appeal to those who realize the value of technical and specialized knowledge as applicable to railways. Railways need specialists, and to produce the best results specialization is desirable; in fact, is a necessity.

The various committees of this association may be looked upon as specialists, as they are, in a complete sense, representative of every department of railway construction. In the assignment of work under the care of investigation of these committees, it is the aim of the board of direction to establish a line of policy which, if adhered to, will attain certain results—a policy, the effects of which will demonstrate in a practical manner that in order to produce economic efficiency in train operation and the consequent permanent beneficial results in railway administration, economics as a science must be more carefully studied, and more generally applied in every feature of railway location, construction, operation and maintenance.

Although these committees are composed of specialists—and there is much efficacy in such a status—the association itself, acting as another great force, is predominant in blending into one harmonious whole the various interests involved. The influence, therefore, acquired by the association through the means of its conventions and supplemented by its "Manual of Recommended Practice," serves as a great balance wheel in preserving that equilibrium of forces necessary for the success of any undertaking.

During the year 1909, 4,866 miles of railway—exclusive of second, third and fourth tracks—were constructed and placed in operation in the United States and Canada, 1,138 of which were in Canada. Compared with the construction records of some former years, the amount added in 1909 did not increase the aggregate mileage to an appreciable degree, and, notwithstanding the recovery from the general stagnation in transportation matters which had existed, it might be a question whether or not during the year new railway enterprises and extensions of existing lines have kept pace with the increase in the industrial features of the country and its immediate needs, due to the rapid advance in agricultural development now going on.

It is not, however, the purpose of this address to consider the reasons why the percentage of mileage added during the year was not greater, for it may be said that beyond having an interest of a general nature, such as may be accepted as universally shared in, it seldom comes within the special purview of the railway engineer to study in detail economic laws which govern eras of commercial prosperity. Neither does it directly belong to his province to question the attitude of the federal or state legislatures towards railway interests, or to analyze the complex factors which frequently produce the conditions leading to business stagnation or financial crises.

To the engineer in such matters the prime factor of import for the time being is trade and economic conditions as they exist, and it is in the degree in which such conditions are active that becomes the potential in his everyday life and avocations. From the engineer's standpoint, it is more desirable to anticipate the future and to consider and plan what has yet to be done, rather than to view the present situation in the light of what has not been accomplished. This statement, however, by no means implies that retrospect for work that has actually been done is unprofitable, for the members of an association such as this can well afford to review the records of construction of some portions of lines built during the past year. In the official descriptions of such construction it is clearly indicated that many novel and interesting engineering problems presented themselves for solution, and the progressive methods used in every branch of the work

*From the address of President William McNab, at the eleventh annual convention of the American Railway Engineering and Maintenance of Way Association, Chicago, March 15, 1910.

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show that system, as applied to railway operation, has made a substantial advance and become more highly developed than in any other of the industrial arts.

In regard to lines and portions of lines built and placed in operation during the year, a review of the situation in general is convincing of the fact that certain extensions with a view of "transcontinentalism," and the construction of new roads with a similar object, was not only a feature of the year, but it contributed largely to the gross mileage built.

It is not possible, and even if it were so, it would no be desirable in this address to enumerate or analyze the general work on railway construction during the past twelve months. (Mr. McNab here mentioned the extension of the St. Paul to the coast and the opening of the Western Pacific from Salt Lake City to Oakland). Two other roads, at present under way, viz., Spokane, Portland & Seattle Railway and the Kansas City, Mexico & Orient Railway, will, when completed, also form parts of transcontinental systems respectively.

The Grand Trunk Pacific and National Transcontinental, is at present being rapidly constructed on the most approved modern lines from the Atlantic to the Pacific entirely within the Dominion of Canada. The length of the main track of this railway will be 3,561 miles. Five hundred miles were built and placed in operation in 1909, and 1,200 miles of main track at present under construction. The whole of the main line of this railway has been permanently located. It crosses the Rockies at an elevation of only 3,712 feet, and is being constructed on an entirely low-grade basis. It has only one summit between the prairies and Prince Rupert on the Pacific coast, and with the exception of a stretch of 20 miles where the grade is one per cent, its ruling grade through the mountains is 4-10 of one per cent. It will not be difficult to realize, therefore, that the line will be admirably conditioned for heavy traffic.

Such revision work, double-tracking and other permanent betterments (as distinct from ordinary maintenance) as have been undertaken throughout the country, have been characterized by mature judgment in carrying them to completion. The longest individual stretch of double-tracking an existing line was on the Canadian Pacific, from Fort William, Ontario, to Winnipeg, Manitoba, 417 miles. In conjunction with this work the limiting grades against east-bound traffic were reduced from one per cent (not compensated) to 4-10 of one per cent (compensated).

Among the most notable of the railway engineering structures which were completed during the year may be mentioned the Susquehanna bridge of the Baltimore & Ohio Railroad at Havre de Grace, Md.; the Lethbridge viaduct over the Belly river on the Crow's Nest branch of the Canadian Pacific Ry.; the new bridge of the Pittsburg & Lake Erie over the Ohio river at Beaver, Pa.; the new spiral tunnels of the Canadian Pacific Ry. in the Rocky mountains.

It is interesting also to note that in the month of November last, although not as yet completed for ordinary operation, a Pennsylvania Railroad train passed through the Hudson river tunnel for the first time.

In the carrying to completion of the railway engineering structures mentioned and many others built during the past year, as well as in most of the great number in course of construction throughout this great country, an influence traceable primarily and directly to the organization and working of the American Railway Engineering and Maintenance of Way Association, and which has already been referred to, is apparent, and such influence has been manifested as well in the development of every important detail connected with this particular section of industrial activity.

As far as the direct interests of the association and the work of your committees for the past year are concerned, it will be observed that for satisfactory reasons the reports

of two of these committees are merely those of progress, but they are indicative of excellent material which will be worked upon, and from which practical information will eventually be obtained. A reference to the other reports will be self-convincing of the businesslike and scientific manner in which the details under investigation have been dealt with and focused to conclusions by these respective committees, and which you will be asked to pass upon in open convention.

The American Railway Association has placed at our disposal the means for employing an expert to superintend the tests of rails at the several mills on a uniform and scientific basis. Such tests will be carried on under the direct auspice of your committee on rail. Valuable results are confidently expected from the work thus to be undertaken. Good rail, being of fundamental importance to a railway, this committee has been most zealous in its determination to leave nothing undone that will bring about conditions in design and manufacture that will be satisfactory to the railways in general.

The board of direction has for some time past been considering the advisability of revising the existing constitution of the association. Some of the changes proposed are minor in character, while others are more far-reaching in their scope. The present form and the proposed form have been printed and issued to the members for their consideration, and it is suggested that each one of the proposed changes be carefully studied in order that the final vote may be looked upon as given after earnest consideration of future effects.

Last July our esteemed treasurer, Mr. W. S. Dawley, who had occupied that honorable office acceptably since the formation of the association in 1899, tendered his resignation as such to undertake railway construction work in China. The board of direction realizes that the association had in Mr. Dawley an efficient officer, and desires to place on record its regret at losing one who has rendered valuable services, not only as a member of the board, but also as a custodian of the finances of the association during the past ten years.

We have lost a number of valuable members by death during the year, among them being H. F. Baldwin, at one time a director of the association; James Keys, vice-chairman of the committee on wooden bridges and trestles (Mr. Keys has contributed very materially to the success of the committee and we are indebted to him for a large amount of valuable data); G. A. Casseday, another member of the same committee; J. W. Schwaub, a valuable member of the masonry committee for a number of years; E. J. Randall, H. M. Steele and James Gray.

At the close of your president's term of office as such, he desires to acknowledge his appreciation of the hearty co-operation of the board of direction as well as of the membership in general, in his efforts to satisfactorily administer the affairs of the association. It affords him much pleasure to feel that the association stands on a high plane, and, having been intimately connected with its work from the beginning, he would be devoid of proper spirit did he not feel that his practical interest in that work would never lessen.

Mr. A. R. Fugina, assistant engineer of the signal department of the Chicago & Northwestern, has been appointed office engineer. Mr. R. M. Phinney, chief draftsman, succeeds Mr. Fugina, and Mr. H. O. Morgan succeeds Mr. Phinney.

Mr. John H. Sample, aged 61 years, assistant engineer of the Pennsylvania lines west of Pittsburg, who assisted in preparing plans for many of the big improvements along the Fort Wayne system during the past ten years, died suddenly at the Fort Pitt hotel, Pittsburg, March 4,

Mr. W. A. Peddle, assistant signal engineer of the New York Central & Hudson River and the Boston & Albany, has become connected with the Hall Signal Co., New York. He will have charge of the estimating and circuit department and of the construction work east of Buffalo, N. Y., and Pittsburg, Pa.

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Among The Manufacturers

At the Coliseum During The Maintenance of Way and Signal Conventions

The Barrett Manufacturing Company's exhibit consisted of their specifications which are clearly and carefully worded with a view of standardizing the use of coal tar pitch and tarred felt, so that the best value will be obtained from the use of these materials in roofing and waterproofing, and they had for distribution line-drawings showing the details of application when the Barrett Specifications are used. From these drawings blue-prints can be made, and in this way architects and engineers can print the details of a Barrett Specification roof in with working drawings. The National Association of Master Gravel and Slag Roofers of America have adopted as their standard the Barrett Specifications. Waterproofing is a subject of increasing interest to the engineering profession, and coal tar pitch is recognized as the standard material in waterproofing. The conditions covering its use, however, are so varied that each job is a problem by itself. That the Barrett Manufacturing Co. is in a position to give competent advice regarding a proper use of their materials for this work was shown by the views and specifications.

Another subject of special interest to maintenance of way engineers were the views showing the laying of wooden floors directly on the ground without air space beneath, and the experience of firms like the American Locomotive Co., and General Electric Co. show clearly that this can be done in a way so the wooden floors will last as long as wood in any part of a building.

The exhibit of Fairbanks, Morse & Co. was one of the largest, most interesting and varied, embracing a generating set, a combined gasoline engine and pump, a standpipe, an extensive assortment of gasoline motor cars, lever jacks, hydraulic jacks, ball-bearing jacks, track drills, cattle guard, etc.

The generating set was in operation, supplying lights to the exhibit. It consisted of a 9 h. p. special electric engine, direct connected to a 5½ k. w., 110-volt dynamo. This is the same kind of outfit that is used by railroads in connection with storage batteries for operating signals. Usually these sets are direct connected, but they are also supplied in some cases to operate by belt from engine to generator.

The combined gasoline engine and pump shown was an 8 h. p. outfit.

While manufacturing various designs of rigid and flexible spout standpipes, the only type shown at the exhibit was that known as No. 10 telescopic spout. The advantage of this style of spout is that no matter what their height may be, the discharge end can be introduced into the manhole of tenders on account of the range of movement in the spout, which, in the one shown, was about 5 ft. practically in a straight line.

A new design of 40-ton geared lever jack was also shown, the jack being constructed on entirely different lines from all other geared jacks made heretofore. The automatic lowering device on this jack is so arranged as not to be in service while the jack is raising the load. The bearings are all bronze bushed, and the gears and pinions are made of specially hardened steel, to insure the jacks giving the best of service.

The Duff-Bethlehem forged steel hydraulic jacks were also shown in this exhibit. The base and cylinders in this jack are forged in one piece, which does away with the joint between the cylinder and the base that is found in all other types and is a frequent source of annoyance on account of leakage. Other special claims for the jack are that the weight will run anywhere from 20 per cent to 50 per cent under jacks of other

types of similar capacity, and also that they will operate in any position, vertical, diagonal or horizontal.

The exhibit of motor cars embraced several types:

No. 2J.—A light direct connected inspection car, that will carry three people, at varying speeds up to 30 miles per hour.

No. 15.—A four passenger, two seated inspection car, with upholstered seats, body mounted on springs, a very comfortable and easy riding car.

No. 14.—Section motor car, designed especially for section foremen's use, simple and powerful.

No. 13.—Combined hand and motor car; being a hand car with an air cooled motor mounted thereon, and so arranged that the propelling lever can be used either independently or in connection with motor.

No. 27.—Section motor car, direct connected type, with walking beam and throwout pinion.

No. 26.—Section motor car of the direct connected type, two-cylinder, air cooled engine, enclosed dust proof crank case. This car has a capacity for 10 or 12 men, and a range of speed from 8 to 30 miles an hour.

Other articles too numerous to describe were also exhibited by this company.

The Adams motor car was exhibited by Burton W. Mudge & Co., Chicago. The car is very light, the four-wheel model shown in the cut weighing only 270 lbs., and is so well balanced that one man can easily handle it alone.

It is equipped with a two-cycle, three-port, air-cooled jump spark engine, controlled by a throttle lever, spark lever and compression relief lever for starting and coasting. It is supplied with wood center wheels, M. C. B. tread and flange. The makers claim for the car simplicity, durability, cleanliness, convenience, safety and economy.

The Safety mail crane for delivering mail pouches to moving trains has the following points of merit: It insures safety to employes, it is reliable, simple, durable and economical. The crane holds the pouch up and away from the rack until released by the action of a U-shaped trip on the front tender truck which engages a trigger encased in a self-closing box in the track. A swivel finger and spring hold the pouch to the crane arms but allow its removal in the direction of the train movement without resistance. All parts are of steel, insuring a light, durable structure and are made interchangeable. The four cuts show the steps in the operation of the device. Burton W. Mudge & Co., Chicago, are the selling agents.

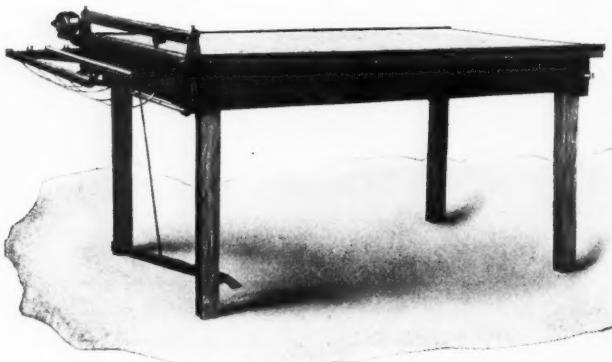
Pease Automatic Blue and White Printing Machine

The C. F. Pease Co. of 167 Adams St., Chicago, had in operation one of their continuous automatic machines for making white prints direct from a tracing without a negative. Engineers have long appreciated the advantage of white over blue prints for many purposes, but the slowness of the negative process and the unsatisfactory results obtained have prevented their use in any large volume. By the Pease automatic process white prints (blue lines on white background) are made as quickly as blue prints, and with their automatic machinery the cost is no more than blue prints made by the ordinary method. By their process they print, develop, wash and dry by one continuous operation, delivering the prints at the end of the machine automatically wound up ready for use. Thus it is possible to make profiles of any length in one piece without stick mark or wrinkle, while smaller prints, either from cloth or paper tracings or typewritten work, can be run alongside of the profiles. These prints are made on a high grade paper, which is said to be practically without shrinkage, and to stand a great deal of rough

RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

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usage, while the prints themselves are absolutely fast color. With this paper notations can be made either with India ink or ordinary writing fluid and the ink will not spread as on ordinary blue line prints. With the Pease eradicating solution and blue ink it is possible to make changes and additions without defacing the print. It is also possible to make a print from a print, provided the lines in the original tracing are fairly



Motor Driven Trimming Table.

strong. The makers say that the process is meeting with great favor among engineers, and also with auditors for statistical work, either from pen and ink or typewritten copy.

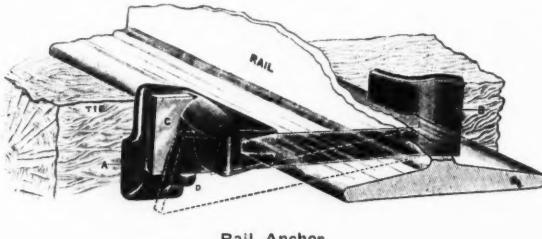
The company is turning out a combination machine so arranged that either blue or white prints can be made with the same equipment, changing from one to the other while the machine is in operation. Only one man is needed to handle a machine. White prints can be delivered fully dried within from 8 to 10 minutes from the time the first tracing enters the machine. The prints come through at the rate of 50 to 75 yards per hour. The entire apparatus for printing, washing and drying is contained in a space about $6\frac{1}{2} \times 6\frac{1}{2}$ ft., and the machine is so clean and noiseless that it can be placed in the corner of the drafting room without annoyance.

American Valve & Meter Co., of Cincinnati, exhibited the Poage Improved Automatic Water Columns with Feumer drop spout. Anderson's economy switch stands.

The Pease company also showed one of their motor driven cutting and trimming tables. This consists of a table of solid oak 4 ft. x 6 ft. long, to the right hand end of which is attached a cutting and trimming device. This is very rapid and convenient in operation and is very exact, cutting tracing cloth as well as paper. The revolving cutting knife is motor driven and is rotated positively by mechanical means, not depending on friction against blade or paper, and therefore will cut the thinnest paper perfectly. It will also cut from five to ten sheets at once. The knife is electrically operated in either direction; is stopped and started at any point by a switch.

Vaughan Rail Anchor

The Vaughan automatic rail anchor, an anti-creeping device. It consists of only two parts, a malleable iron shoe and a spring steel yoke.

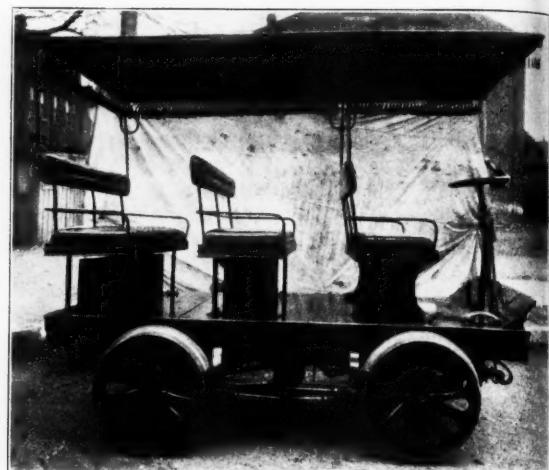


Rail Anchor.

Malleable iron guard rail clamp. Tie plate guard rail fastener. Reinforced malleable iron and pressed steel rail brace.

The Advance Motor Car

The Advance Power Co., exhibited a nine passenger inspection motor car—about 1,200 lbs. weight—equipped with the



Nine Passenger Motor Car.

"Advance" engine, two cycle, air and vapor cooled, two cylinder opposed type, developing twenty horse power—and the "Advance" Rolling Contact Transmission. The unique features of the car which should commend it to railway men are given below:

The engine, the entire elimination of all valves, gear cams, springs, water connections, piping, radiators and pump, thus dispensing with every part liable to wear out or break or subject to crystallization by the constant jar incident to rail travel. The engine has only three moving parts, the crank shaft, the connecting rod and the piston. The simplicity, durability and high power developed are all the result of a new method of handling the mixture (gasoline and air) which keeps the engine cool, converts the mixture into a fixed gas and gives perfect combustion.

Equally simple and efficient is the rolling contact transmission consisting of one large fibre faced disk, keyed on engine shaft and serving also as flywheel for the engine. Against the face of this disk two smooth iron wheels on counter shaft transmit power to rear axle of car through chain drive.

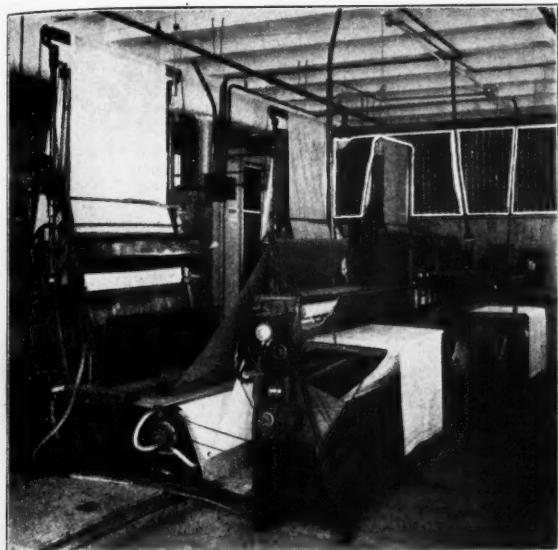
Control apparatus—There is only one lever—throw it forward and the car moves forward—pull the lever back and the car reverses at the same rate of speed. To regulate speed, one hand wheel on post resembling the steering gear of automobile, draws the two smooth iron wheels together or spreads them apart on the face of large disk, thus regulating the speed from zero to maximum.

The car exhibited is said to have travelled thousands of miles and to have a record of seven-eighths of a mile in sixty seconds from a standing start to a standing stop carrying six passengers, also to have negotiated a twelve per cent grade with ten passengers at 15 miles per hour from standing start at foot of grade.

The special feature of engine and transmission as above described are fully protected by U. S. and Foreign patents.

The Company makes also Motor Section Cars and double and single truck Motor Passenger Cars.

Chicago office, Suite 812, Hartford Building, Chicago, 140 Dearborn St.



Automatic Printing Machines.



Present Home of St. Louis Surfacer & Paint Co.

Paint Specialties

The St. Louis Surfacer & Paint Company, incorporated September 19th, 1903, with W. S. Avis as President, H. C. Avis, Secretary and Treasurer, and C. E. Koons, General Manager, started an entirely new business catering absolute-

ly to railroads, and manufacturing only specialties for railroad use.

Quality, first and foremost, with a practical knowledge of the real needs of the railroad paint world enabled the St. Louis Surfacer & Paint Co. to forge rapidly to the front as a manufacturer of this class of paint. Considering its humble beginning in two small rooms, the growth of this firm has been marvelous in the few years of its existence, and can only be attributed to the determined stand at the start to furnish nothing but the best, and to give full value for the price. The result has been the confidence of railroad officials in the quality of the St. Louis Surfacer & Paint Co.'s products. Their reputation for strictly following specifications when furnished is beyond reproach, and as to the durability of their own specialties, they fear no competitor and claim a quality second to none. The improved quality of regular lines has always placed the products of this company at the top, and all they ask in the way of new business is a comparative test with that which you are using. The rapid increase in business from the beginning to thirteen floors stocked with material and machinery in the space of seven years shows the results in the amount of business that is being handled at the present time. The main specialties of the firm are fully and satisfactorily meeting the demands of the railroad steel equipment for durability, for both passenger and freight cars, also structural and steel bridge work. The St. Louis Surfacer & Paint Co.'s "Metalsteel" Paint is one of the first special paints put forth for this class of work, and wherever it has been tried and tested has proven its merits above the common run of paint products. Years of practical experience by the heads of this company with the largest manufacturing interests in car building have well fitted them for their work in placing on the market specialties adapted for different kinds of work.



First Home of St. Louis Surfacer & Paint Co.

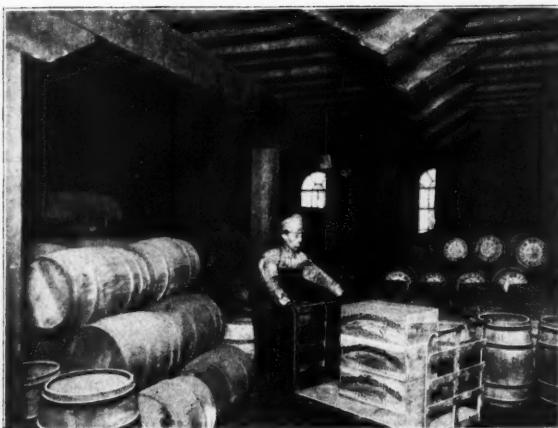
Triple Lock Switch Stand

The Triplelock Switch Stand, H. C. Williams, patentee, made by the W. F. Bossert Manufacturing Co. of Utica, N. Y., illustrated herewith was one of the exhibits. Its makers claim for it as follows:

It has long been desired in railway service to provide a practical switch stand with a signal operated in connection therewith, whereby the stop signal must be displayed before the switch can be opened, and so constructed that when open the signal cannot

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Sectional View of Warehouse St. Louis Surfacer & Paint Co.



Chicago Office, St. Louis Surfacer & Paint Co.



Sales Dept., St. Louis Surfacer & Paint Co., St. Louis, Mo.



Chicago Office, St. Louis Surfacer & Paint Co.



W. S. Avis, President, St. Louis Surfacer & Paint Co.



H. C. Avis, Secretary and Treasurer, St. Louis Surfacer & Paint Co.



C. E. Koons, Gen'l Mgr., St. Louis Surfacer & Paint Co.

RAILWAY
ENGINEERING
AND MAINTENANCE OF WAY.



A. D. McAdam, Vice President, St. Louis Surfacer & Paint Co., Chicago.



B. A. Hegeman, Jr., Pres. U. S. Metal & Mfg. Co., New York.



H. N. Turner, Manager of Sales, St. Louis Surfacer & Paint Co., Detroit.



F. C. Dunham, Special Sales Agent, St. Louis Surfacer & Paint Co., New York.



New York Office, St. Louis Surfacer & Paint Co.—B. A. Hegeman, Jr., at Desk.



C. W. Rhoades, Special Sales Agent, St. Louis Surfacer & Paint Co.



Mechanical Engineer's Office, St. Louis Surfacer & Paint Co., R. R. Depot, New York.



Sectional View of Mill Room Where Metal Steel Is Ground.



Accounting Department, St. Louis Surfacer & Paint Co.



Exhibit Room, Railroad Dept., New York.

be changed to clear until the switch has been closed and the points of the switch locked.

It accomplishes the same purpose at a single switch that an interlocking plant does at a group of switches.

It locks the switch points with facing point lock in both positions.

The points must be tight against the stock rail before the operating lever can make its full movement.

It is the only switch stand ever produced that has the operating lever parallel to the track with a movement through 180° which unlocks the point, throws the switch and re-locks the points in both positions with the facing point lock.

It is the only switch stand that will not operate unless the movement of the switch points corresponds with the movement of the operating lever.

It has a signal lever attachment to operate either a mechanical or power-operated signal.

It has an absolute lever lock between the switch and the signal lever, so arranged that the signal lever must be in the full reverse position before the switch lever can be moved, and after the switch lever movement has been started the signal lever cannot again be put normal until the switch lever has been returned to its normal position and switch points locked.

It has a dust and waterproof circuit controller attached to the signal lever, which takes the place of the present switch controller from the movement of the switch points.

The circuit controller in connection with the switch stand has a marked advantage over all others for the control of automatic block signals or power-operated distant switch signals as the signal lever must be reversed before the switch lever can

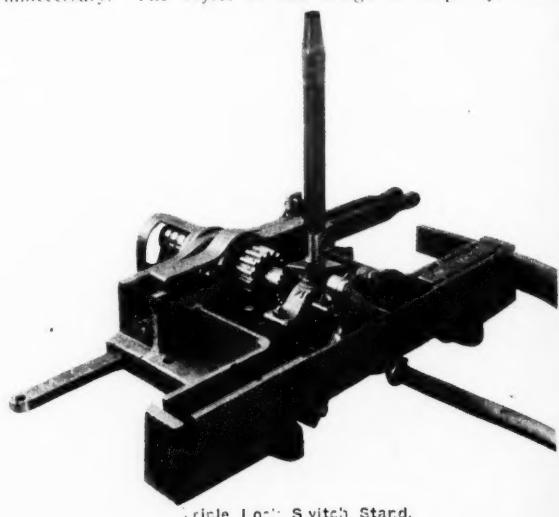
be moved to unlock the points. With the usual arrangement of switch circuit controllers, the movement of the points controls the signal, which is a bad practice. This is overcome by the use of the circuit controller in connection with the Triplelock "Fool Proof" switch stand.

It is the only switch stand ever produced that throws the switch points and the derail at the same time, both being actuated direct from the operating lever and independent of each other outside of the switch stand. Derail connection in switch stand has six inches positive movement. The construction of this switch stand is simple and strong, and duplicate parts can be replaced without difficulty.

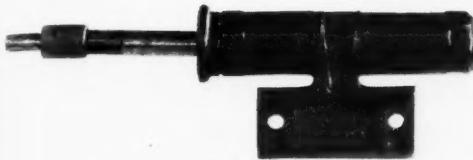
It can be applied to a right hand or a left-hand switch, or can be installed to operate moveable point frogs. A special connection with the signal lever is furnished when desired, which will lock the derail in the derailing position.

It is the only switch stand ever produced that meets all the requirements of both the maintenance of way department and the signal department. This switch stand is also furnished with an electric lock, which can be controlled from any point, as in connection with approach locking. This electric lock is very simple and positive; dust and weather proof. All stands have an automatic manual control lock, making it impossible to insert padlock unless the levers are in normal position. Both locks are attached to the stand proper and so placed that they will not prevent the stand from being installed between tracks.

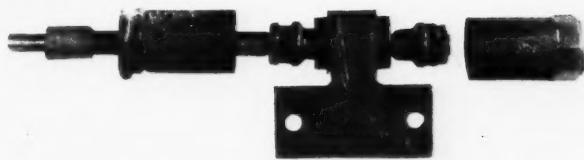
The Bossert company also exhibited a one-piece insulated rail joint shown herewith. The illustrations render description unnecessary. The object of this design is simplicity, ease of



Triple Lock Switch Stand.



Bossert Point Adjuster.

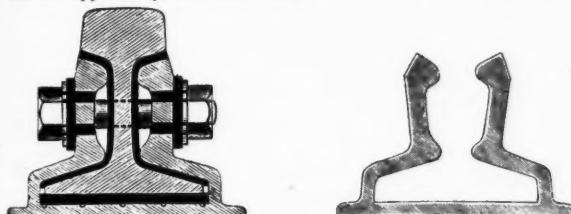


application and removal and to provide a means of keeping bolts tight without the aid of nut locks.

Another product of this company is the semaphore blade clasps, two designs of which are shown here. The following points of merit are claimed for this device:

Less time required to make changes. Big saving in bolts and nuts per year. Especially of great benefit in winter. Prevents splitting of blades. Cost of maintenance is greatly reduced. Iron straps as generally used are eliminated. Two bolts and nuts only are required for fastening. One, and never more than two, bolts required.

They have a larger bearing surface than the old style clasp; are much lighter in weight and stronger. This does away with the objection heretofore made by signal men, that the clasps made of malleable iron were unnecessarily heavy. These clasps can be applied by unskilled labor.



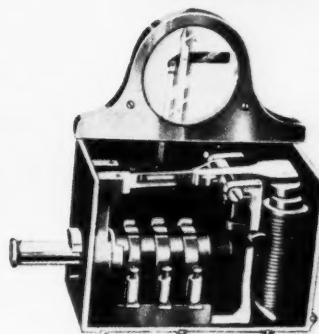
Bossert Insulated Rail Joint.

Insulating and Roofing Materials

The Philip Carey Company, of Cincinnati, O., manufacturers of pipe and boiler insulating materials make standard 85 per cent magnesia covering for high pressure surfaces and also "standard asbestos," "asbestos air cell," "alternant" and other forms of pipe and boiler insulations for steam, hot and cold water surfaces. For refrigerator lines the Carey Company furnishes "Nonpareil Cork." This company also manufactures everything in the asbestos line, including asbestos packing sheathings, boards, cloths, etc.

"Linafelt," a flax fibre quilt sewed between two sheets of building paper and used for sound deadener and sheathing purposes, is another product handled by this company. It is advertised as being 38 times as effective as ordinary building paper as a non-conductor and to reduce fuel consumption 40 to 50 per cent. It is also used as a deadener of sound. The Western Roofing & Supply Co., 24th & LaSalle Sts., Chicago, Ills., handle this product.

The main exhibit of this company was a roofing material particularly adapted to railroad buildings of every description, such as round houses, shops, warehouses, called the Carey Roof Standard. It is a standardized roofing that has been on the

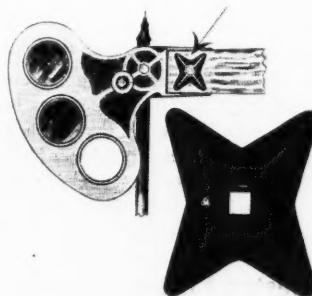


Electric Lock for Triple Lock Switch Stand.

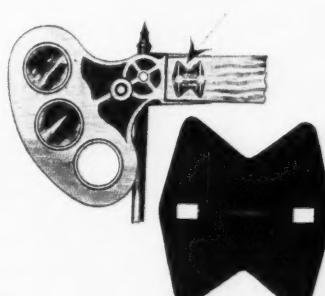
market for over twenty years, and is used extensively by railroads. It is a cement composition, made of the high grade materials, so constructed that it will offer the greatest resistance to severe conditions when used in railroad work. Carey's Roofing is said to retain its flexibility and not to dry out or crack and break from continual exposure to weather. It is adapted to flat and steep surfaces and its method of application is simple.

Fiber Steel Battery Chutes

The L. S. Brach Supply Company at 143 Liberty Street, New York, are the manufacturers of an innovation in signal equipment; the "Fibre Steel Battery Chute," designed to combine strength, insulation, warmth and lightness with a ruggedness of construction that guards against damage either from handling or through length of service. The chute is made of fibre with a jacket of metal so distributed as to afford mechanical protection. It has a wide malleable iron collar at the top and a wrought iron band two feet from the collar holding in place a sheet metal shell of heavy gauge which extends between the collar and band. This is a protection against injury to the fibre above the ground as well as against frost. There is a malleable iron protecting rim around the bottom to protect against injury from handling. The chute proper is made of one piece of thoroughly impregnated bituminized fibre seven feet long. The bottom, three inches thick, is covered with tar and canvas before the metal rim is put on. This is a protection against the effects of water or chemical action. No gray iron is used in the chute. A malleable iron cover is provided, fitted for a snap-lock or padlock. The use of the snap-lock on a chute is a novel method of locking. It offers better means of guarding against tampering than with the use of padlocks and



Semaphone Blade Clasps.



April, 1910.

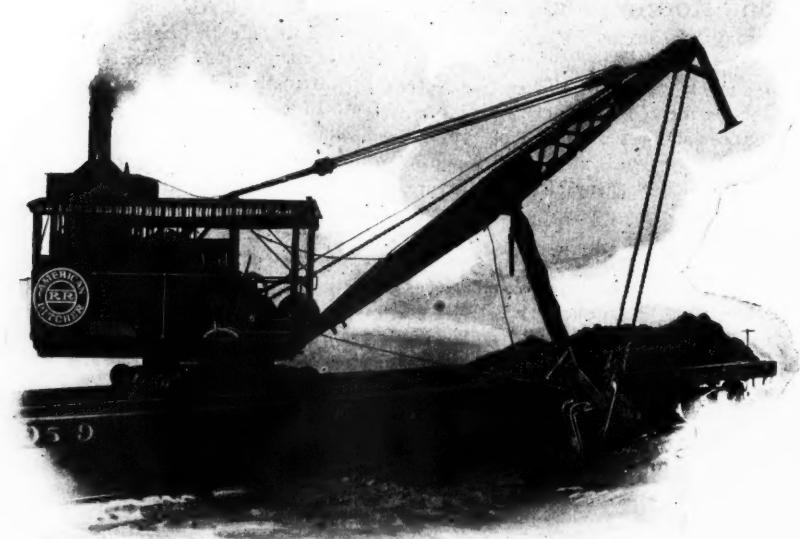


Linofelt Sheathing.

holds the cover more securely. An elevator is furnished which also embraces several new ideas. This elevator is equipped with three upright rods which act as a tripod to support it while the batteries are being renewed, preventing the elevator from being blown or thrown over. This new feature should be highly appreciated by batterymen. The elevators are wired complete, the wires being connected to spring clip binding posts of special design, offering a means of rapid and secure connection.

Metallic Ties

An invention said to be the result of 28 years of experiment, patented by W. W. Mechling, of Pittsburgh, Penn., is said to overcome the objections to metallic railroad ties now being tried on some of the railroads. Steel ties now in use have given trouble by not holding the rails securely and by producing such a solid roadbed that the rolling stock suffers from shock. Mr. Mechling's tie is of such shape that a wooden block is admitted in each end to form a cushion for the rail. This



American Ditcher.

American Railroad Ditcher

We illustrate herewith the "American" railroad ditcher, a moving picture show of which was given at the Coliseum. Over 75 of these ditchers are in use at the present time. The machine is used not only for ditching, but for the auxiliary purpose of pile driving, clam-shell and orange peel bucket work. It can be used as a locomotive crane for handling rails and ties, laying track, etc. It is said that it will displace from 50 to 100 laborers and their foremen, saving for its owner from \$100 to \$300 per day. On this basis it would pay for itself in from 3 to 5 months.

wooden block is reinforced by a wide bearing surface of steel. It is claimed for this tie that it can be manufactured more cheaply than by any other of the same class and as the bearing surface under the rails is greater than with other ties quite a saving may be effected in the number of ties required. Mr. Mechling's invention has been very highly spoken of by several well known engineers who have examined or tested the device.

Asbestos Lumber Smoke Jack

There is on the market an asbestos lumber smoke jack made from hardened plates of asbestos lumber, supported at the cor-

April, 1910.

ners by asbestos angles of the same material, joined together by brass bolts, the whole jack being hung to the roof by a yellow pine framing on the outside of the jack.

This asbestos lumber is a combination of hydraulic or portland cement and asbestos fibre put down under pressure. The result is a material that is fire, water and acid-proof, and resistent to the action of the elements. Instead of deteriorating while in service it is said to require only the action of the atmosphere to maintain and preserve it. It will last for an indefinite period. It is of light construction, and therefore the roof timbers need not be as heavy as when cast-iron jacks are used, thus saving in the first cost of an engine house. The Franklin Mfg. Co., of Franklin, Pa., are the makers.

The Rockford Track Weeder

The Rockford track weeder, which was on exhibition at the Coliseum, attracted considerable attention from the visitors. This is the invention of "Jack" Duntley, as he is known to all railway men, who one year ago presented the Rockford gasoline motor car for section use. This weeder was on exhibition for the first time; although service tests were made last summer.

In order to arrive at the average cost of weeding track from the end of ties to grass line, reports were obtained by the Duntley Manufacturing Co. from ten road masters. These reports show that it requires 6 6-10 laborers to clean one mile of track in one day, and with wages at \$1.50 per day this work would cost \$9.90. When this work is performed by hand it is necessary to weed the track about three times per year, which would make the weeding process cost \$29.70 per mile each year.

The Rockford track weeder, according to the makers, will clean 20 miles of track in one day, at a cost of 60 cents per mile, as follows:

1 man at \$3.00.....	\$ 3.00
4 men at \$1.50.....	6.00
Gasoline	2.50
Lubricating oil50
	—
	\$12.00

Or, 60 cents per mile.

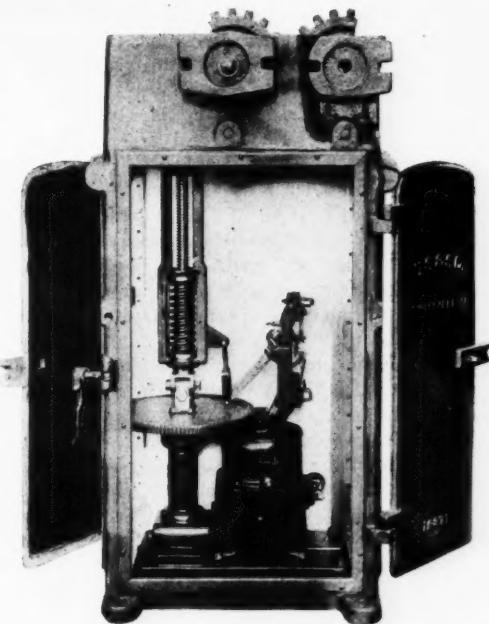
The machine removes weeds by the roots, and only two cleanings per year are necessary, making the cost of cleaning each year \$1.20 per mile, as opposed to \$29.70 by the old method. This shows a saving of 95 per cent, on which basis the machine will pay for itself in one week.

The machine is very similar to a harrow or cultivator, and is rigged to a Rockford gasoline locomotive No. 6. There are two upright posts with crank and chain attachment for lowering and raising arms to which are attached the teeth of the harrow, and at the outer end of these arms are idler wheels which ride the grass line and keep the harrows at the proper elevation to perform the most efficient service. It is simple and is well constructed, having practically no breaking parts. For railways which do not desire the weeder attached to a gasoline locomotive, it can be furnished for use with a team of horses or a light steam locomotive.

The company advises that several orders for May and June delivery have already been received.

Crossing Gates Operated by Electricity

The exhibit of the Union Switch & Signal Co. comprised the following: Crossing gate operated by electricity. The motor may be either 110 volts D. C.; 110 volts, single phase, 60 cycles; 110 volts, single phase, 25 cycles; 55 volts, single phase, 25 cycles. These gates are operated by two double pole double throw switches in the tower, and may be reversed at any part of their movement. This motor is said to consume in one operation only a trifle more than the power consumed by a 16 c. p. lamp burning for one minute.



Electric Crossing Gate Mechanism.

Style "B" electric-motor signal. This type of semaphore signal was first installed in 1898; today it is said that over 36,000 are in service and on order. The original design has been modified only in detail.

Style "S" bottom post electric motor signal. This is a modification of the Style "B" signal and is designed to operate an arm in three positions with only one slot.

Top post, three-position, electro-pneumatic signal. This is designed for either automatic block or interlocking work, and can operate on A. C. or D. C.

Top post, three-position, style "T," low voltage signal. This signal has no dashpot, the shock of the blade returning to stop being absorbed by a snubbing circuit on the motor.



Relay Box and Switch Indicator on Cable Post.

This necessitates driving all the gears and the motor backwards; therefore, as an extra precaution, the circuits are so arranged as to cause the motor to pull the signal to stop should it tend to stick clear.

Top post, three-position, style "T," high voltage signal, the same as the former, except designed to operate on 110-volt circuit.

Top post, three-position, style "D" signal. A smaller motor is here used than in style "T," and there is greater gear reduction. A slot is used to engage and disengage the mechanism and the semaphore shaft. One novel feature of this signal is the double-acting air buffer, with mechanically actuated valves, so arranged as to cause retardation both by compression and vacuum.

Electro-pneumatic interlocking machine connected to a motion plate type switch and lock movement. The machine is equipped with electric lights below the levers to show whether or not a track section is occupied.

Multiple unit electric interlocking machine. Motion plate, screw-driven switch and lock movement. Solenoid dwarf signal.

Set of staff machines modified so that they can be manipulated by trainmen, doing away with the necessity for operators, provided all trains stop at all stations.

Controlled manual block instrument connected to upper quadrant, three-position train order signal with universal spectacle.

Cable post with relay box and switch indicator, as used by the Rock Island.

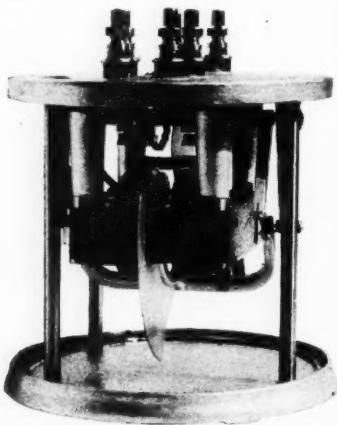
Double disk and semaphore indicator, so arranged in one instrument that one repeats the position of the home signal and the other announces the approach of a train.

Circuit controlled for eight independent circuits. Contacts adjustable.

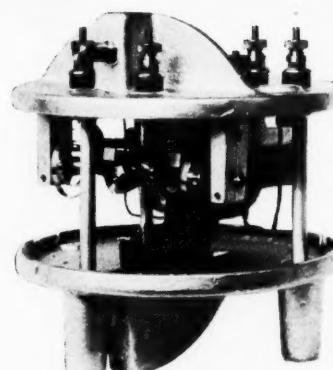
"Electro-pneumatic relay," an electro-pneumatically controlled circuit controller, used as a repeating relay where a great many circuits must be controlled by one relay.

Type 9-C neutral and polarized relays.

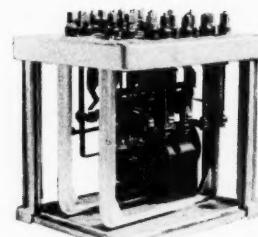
Alternating current relays for use on both steam and electric roads. The newer types shown, in addition to the vane type relay, originally brought out by them, are the galvanometer relay, frequency relay, and an eight-point track or line relay. The galvanometer relay is made either "two" or "three position." This three-position relay is used for the wireless control of distant signals in the same manner as a D. C. polarized track relay. The frequency relay is used on electrified roads having A. C. propulsion. A higher frequency current is used for signal circuits than for propulsion, and the relay does not close its contacts when a difference of potential exists across its terminals due to the propulsion current. The eight-point relay is a modification of the ordinary track relay which is used on the West Jersey & Sea Shore with D. C. propulsion.



Frequency Relay.



Vane Upper, A. C. Relay.



Galvanometer Relay.

Clockwork-driven slow hand release for electric locking circuits.

Storage battery charging switch.

Adjustable resistances to be used with storage battery on track circuits.

Testing sets for relay inspectors.

Deflecting bars, both vertical and horizontal.

Pipe carriers and foundation topes of iron "Sheradized" or impregnated 3-16 in. with zinc dust, so as to prevent rust and make painting unnecessary.

Highway crossing bell, with relay box and sign on iron post.

Multiple tower indicator consisting of a case containing individual indicator mechanisms. These mechanisms slide in and out of the cabinet on guides without interfering with each other.

Carb-Oxide Elastic Metal Preserver

The Blocki-Brennan Refining Co., makers, and the Stockdale-Canterbury Co., general sales agent, 153 La Salle St., Chicago, exhibited the preserving qualities and other properties of their "Carboxide Elastic Metal Preserver."

They conducted hydrochloric and sulphuric acid tests showing the gradual corrosion and destruction of bars of steel not coated with their preservative, and, in the same cans which were coated with Carbomoxide, holding the acids, were steel bars coated with their preservative upon which the acid made no impression. Another demonstration was the salt brine drip. A solution of 24 per cent salt was placed in a can and dripped through a wick on a piece of steel about three feet in length coated with Carbomoxide, set at an angle of 60°. The salt brine ran down this piece of steel and built up large crystals of salt on each side. It was said by the exhibitors that this test had been carried on in the open air sixty days prior to the convention and the coating was still perfect on the metal.

The following is from an address delivered before the Worcester Chemical Club, Nov. 29, 1909, by Stanley D. White, of the Worcester Polytechnic Institute. It was entitled "A New Deporture in Iron Paints":

After having review briefly some of the fundamental principles and theories of the corrosion of iron, Mr. White said: "An explanation of the physical and chemical actions of a new iron paint with which I have made a number of experiments

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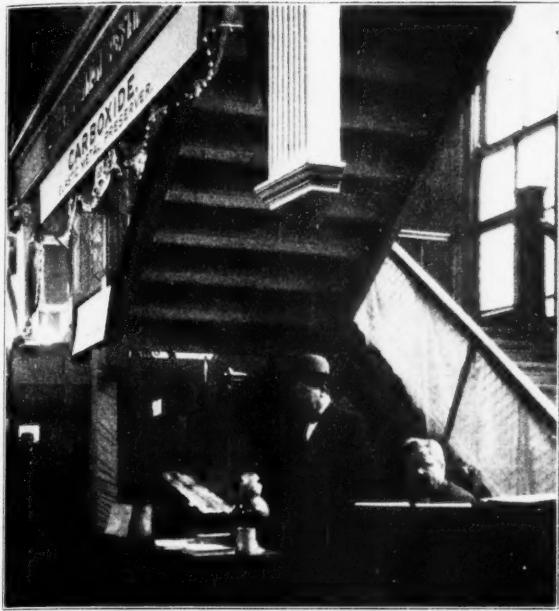
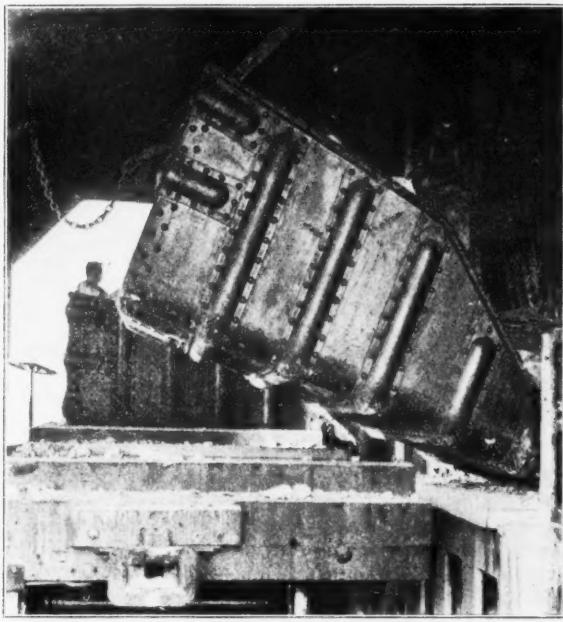


Exhibit of Carboxide at Coliseum.

might be appropriate. The paint to which I refer is called the Carboxide Elastic Metal Preserver, manufactured in Chicago, Ill. I call it a paint because that is the usual term applied to any pigment ground in oil, but strictly speaking it differs from ordinary paint in that the pigment employed seems to exert a chemical action upon the surface of the iron to which it is applied. This pigment is a carbon obtained by distillation from a variety of coal which has thus far been found in only one locality in the United States. The source of the material used and the methods of manufacture have not been made public.

To indicate some of the distinguished features of Carboxide, I will mention a few practical applications that have been made of this metal preserver: Thoroughly rusted and scaled trestle work trolley poles on 22nd Street, Chicago, were painted two years ago last summer, the paint being applied over the rust and scales without any attempt being made to clean the iron. A recent observation showed no outward appearance of corrosion, except where the paint had been removed by abrasion; on the contrary, the coating seemed hard and compact and scratching the coating with a knife seemed to show that the rust had penetrated no deeper. It also appeared that the paint had expanded and contracted uniformly with the iron.

Another practical experiment consisted in painting a rusty iron sheet with Carboxide and placing over the surface so painted a



Car Bodies Covered With Carboxide in Plant of United States Crushed Stone Co., McCook, Ill.

rusty scale six or seven inches long and one-sixteenth inch thick, then painting the scale thoroughly. As time went on the scale adhered harder to the sheet and at the end of a year's exposure in open weather the scale seemed to be a part of the iron itself. I might say that this test proved to be a strong argument for the practical value of the paint, resulting in its adoption to the exclusion of all other paints by some of the largest elevated and steam railroads of this country.

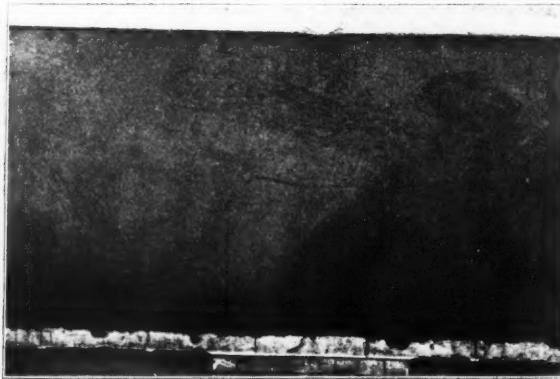
From the facts already recited, together with many others, the conclusions must be drawn that the action of the Carboxide differs materially from that of ordinary paint and that the carbon pigment is the life of the paint. In applying Carboxide to a rusty iron structure the intimately mixed substances are iron rust, which is a hydrated ferric oxide, and the carbon. It is therefore seen that if chemical action results from the intimate mixture of rust and carbon the action must be of a reducing nature and should be accompanied by the formation of carbon dioxide.



North Water Street Terminal of Northwestern Elevated R. R.; 300 Engines Per Day Pass Beneath Preserver in Perfect Condition After Two Years.



Plant of United States Crushed Stone Co., McCook, Ill.



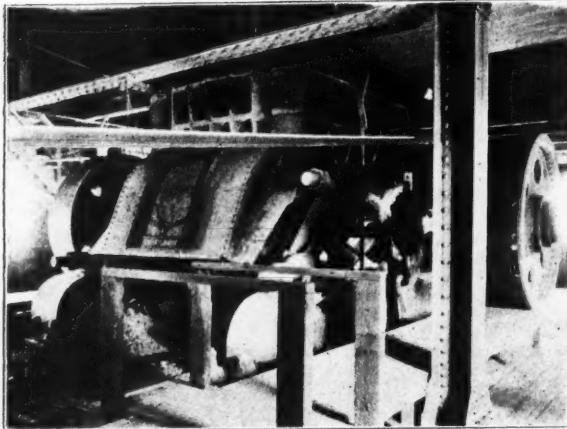
Wheel Guard at Railway Exchange Building, Showing Marks of Wagon Tongues on Plate Without Showing Rust or Deterioration.

"Working upon this theory I performed an experiment intended to determine by a qualitative indication whether or not such reduction actually takes place. In the performance of such an experiment it must be taken into consideration that carbon dioxide may be present from sources other than from the reduction of rust. In order to prevent any error in the experiment due to the presence of dioxide from other sources I prepared a simple apparatus for blank experiments under exactly similar conditions."

Mr. White here explained at length an exacting experiment which demonstrates conclusively that Carboxide actually does reduce iron rust. In conclusion he said:

"Practical work has seemed to show that Carboxide is very well capable of taking care of a rusty structure and keeping it from deterioration. Whether iron rusts according to the hydrogen peroxide theory or according to the electrolytic theory, the rate of corrosion is comparatively slow, depending on the presence of moisture. Carboxide works against this action and therefore should be classed as a rust destroyer."

The accompanying illustrations show buildings and apparatus



Edison Stone Crushing Rolls, U. S. C. S. Co., All Except Working Parts Covered With Carboxide.

at the plant of the United States Crushed Stone Co. treated with Carboxide. This company used Carboxide exclusively for painting metal work.

McRoys Conduits

Within the past year or two, much has been said relative to the operation of block signals on steam railroad lines.

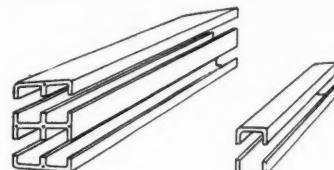
The use of alternating vs. direct current for signal work was

very ably discussed in the paper prepared and read by W. K. Howe, at the meeting of the Railway Signal Association in New York on June 8, 1908.

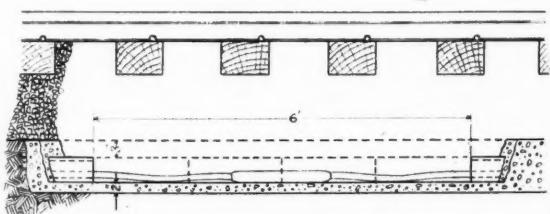
In transmitting electrical energy from the power house to the various signals, it is customary to carry the current either by aerial lines or underground. While the first cost of the former method of construction is lower, the maintenance figures are of much consequence.

The exposure of overhead wires to the elements (such as wind, snow and sleet storms) can cause incalculable damage, as was witnessed around Baltimore, Washington and the South on Inauguration Day, 1909. The property loss alone in connection with the signal systems must have been enormous, beside the delay in train service, which not only lost much time for passengers, but entailed a considerable loss in the destruction of perishable freight.

Another very important feature in connection with this type of installation, and one which should always be carefully considered, is this: It may be desired at some future time to withdraw the present cable from the duct and substitute an-



Split Clay Conduits.



Cable Splice in Conduits.

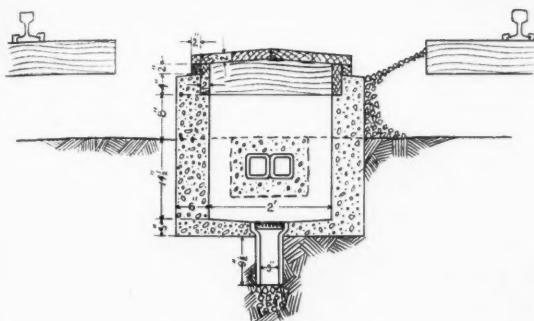
other. This can be easily done by simply severing at each splice. The condition of the copper and insulation would be as good as when first drawn in.

In connection with what is known as the "solid" system, where the cables are laid in a wooden trough and encased with a tar or bituminous compound, or buried in a solid concrete formation, it would be impossible, if so desired, to ever replace them, and entirely new lines would have to be constructed. About the only asset that could accrue from the original cable would be a price per pound for the copper and lead as old junk, and it is doubtful if this would even pay for the labor of taking it out.

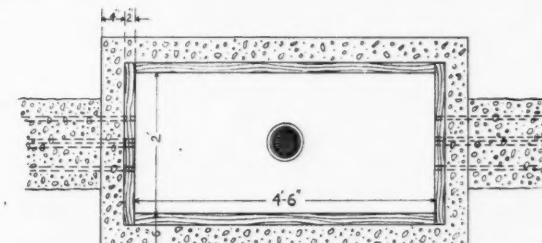
Conduits that contain organic matter, and which in time will decay, metallic conduits that corrode, or cement ducts, which allow a certain chemical action on the lead sheath of cables, are not recommended for this work.

Vitrified clay is a cheaper form of glassware and therefore almost a perfect insulator. Conduits made of vitrified clay afford a protection to the cables from any stray currents in the earth and are water and fire-proof. They give the best mechanical protection and are always readily accessible at any point.

It would be foolhardy to place signal wires transmitting A. C. of 2,200 volts on the same poles with telegraph lines, so that if aerial transmission were adopted it would necessitate the construction of a second set of poles paralleling the entire right of way.



Conduit Junction Box Between Tracks.



In view of what has been said relative to the shortcomings of the overhead construction, leading signal engineers are endeavoring to devise a method of underground construction which will assure complete control and the absolute operation of signals at all times, and at a minimum of cost.

The following is a description of an underground system that has been suggested, and has been approved by an engineer of standing with one of the largest manufacturers of signal apparatus. A subway is constructed of vitrified clay conduits, laid in a trench excavated midway between tracks. Either single or multiple conduits can be used, depending on the number of ducts desired. By the use of clay conduits, less concrete for mechanical protection is required, thus effecting considerable saving in cost of construction. The use of manholes is also eliminated and any one familiar with conduit work knows how the cost increases if any number of manholes are necessary.

Cable manufacturers say, and it has been demonstrated in actual work, that it is a simple matter to rod and draw a three-conductor cable of moderate size into a clay duct 1,200 feet in length. Under the supposition, therefore, that it is intended by the railroad to space their signal posts one mile apart, it would not be necessary to make more than four splices between signals, and divided into equal distances, each splice would be 1,056 feet. After the various lengths of cable above referred to are drawn into the clay conduit, the ends are joined, and the joint is then encased with a split conduit. These are then bound around the outside with wire to hold in place, and then covered with concrete to the surface of the sub-grade as are the regular ducts. A simple marker may be installed close to, this point to indicate its location. As can be readily seen, by this method the use of manholes is entirely eliminated and a continuous length of cable in an uninterrupted straight duct from one signal to the next is obtained.

If it should be desired when planning a transmission system, as above, to add a number of ducts in same trench to take care of the telephone and telegraph wires, the plan would be entirely feasible, and the proportionate cost to each operating company be correspondingly less. The greater the number of

ducts in a trench, the less cost per duct foot, as for instance, it costs nearly as much to excavate for a two-duct run as it would for a six. Junction boxes, however, are recommended where the subway consists of two or more ducts, say every five or six hundred feet, to provide easy access to the cables, for installation of additional cables, and for making any changes subsequently desired.

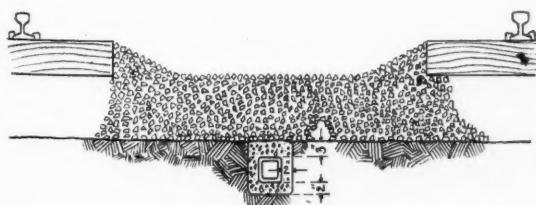
Paint for Steel Construction Work

Engineers have almost abandoned the idea of using any material other than steel for bridges and towers. Railway officials are constructing steel box cars, passenger coaches and mail cars, almost entirely of steel, and, if it is not used in the body, the underframing and spans between the trucks are of steel, doing away with chains and wooden sills, which have been in use heretofore. This, of course, assures great strength, durability, and safety, as well as economy.

Many far-seeing men have anticipated just such a revolution in construction, because of the scarcity of timber and the great development of our steel industry. The use of improved machinery for shaping, shearing and punching the malleable material has also aided in this revolution. These same men who have led and encouraged the adoption of steel construction have been alarmed for some time as to a preserver for these perishable and expensive structures. They know that it is imperative, that it receives, both at the shops and after completion, a coating of some kind, that will arrest and prevent rust. This coating must be nearly as durable as the steel upon which it is applied, must be very flexible, must contract and expand as well as withstand all climatic conditions, sulphurous fumes and gases. Such a material must be had, otherwise the expensive work would be a failure and would add a most dangerous condition of an all important structure.

After years of experience and experiment, directed by the best paint manufacturers, it is said that nothing has ever been discovered that is a better preserver than red lead mixed thoroughly with the best aged linseed oil, although imported Ceylon graphite, ground and cut for the brush with pure oil, has been a strong competitor of the lead pigment. These paints may be dried with any good Japan dryer where quick drying is necessary, but it is rarely that outside steel structural work demands a quick drying paint if any durability is to be expected from such application.

It has been proven that the best pigments, such as white lead, red lead, or the best oxide of any color or kind, whether mixed in oil, or ground, can only last during the life of the vegetable or linseed oil, namely. Tests of from three to five years have proven this beyond question; at the end of that time, such paint begins to crack, part and disintegrate generally, because of the loss of the binder.



Section of Roadbed Showing Conduit.

The binder in paints has caused the greatest trouble as to its durability and preserving qualities; all vegetable oils contain an acid and are more or less destroyers causing rust to set up after disintegration, by allowing the oxygen to enter through the cracks and crevices to combine with the indestructible acid which the oil contains.

Now there is endless proof that any and all paints in which linseed oil is used as a binder perish. Many substitutes have been presented, but none has ever proven as good as linseed oil, so the paint heretofore mentioned has given the best satisfaction up to date.

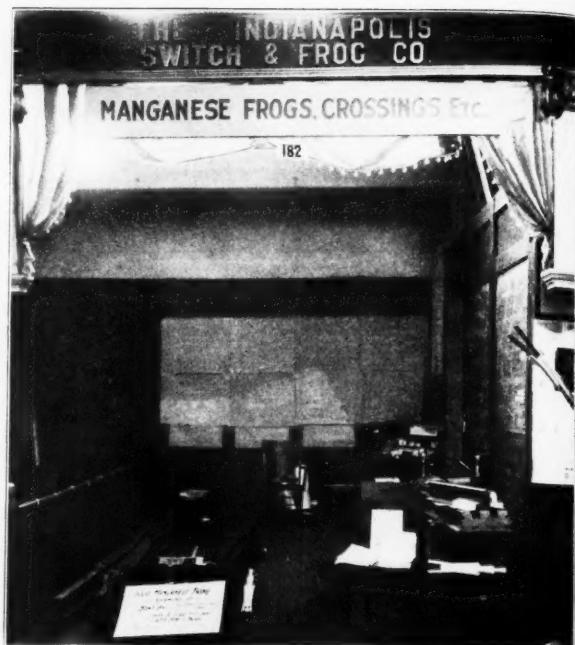
Of late, a paint manufactured by a peculiar and strange process has come to notice. The pigment of this paint is composed of pure pig lead from the mines—not red or white lead, but lead converted into a flour of the finest grade, and flake graphite, floured in a ball mill. This mixture is amalgamated with other unknown ingredients and converted into a solution at from 300 to 350 degrees F. by great agitation in a mill of large capacity. During this process each and every ingredient composing the pigment seems to lose its identity and a new substance is formed which resembles sheet lead. However, it is the oil or binder used with this paint which is of the greatest importance. This oil is made by dissolving the purest carbon into a solution and is non-inflammable; pigment being suspended in this material so that it may be carried in the brush when applied. It is as durable as the pigment itself, will carry the different colors, such as olive green, maroon or slate color, and in applying the pigment the oil remains on top, and any color which may be desired floats on this oil, but under all circumstances the metallic pigment adheres to the steel magnetically and cannot be removed or destroyed by gases, sulphurous fumes or chemicals of any kind. If the color is removed the bright metallic finish appears, which is proof of the metallic coating.

Steel coated with this paint has been subjected to the greatest destroyer of paints or steel and the steel was entirely destroyed while the paint remained in perfect condition, showing a rubber or cloth like sheet, where the steel had been entirely eaten away. Fire has been built upon wood and cloth painted with this material, and afterward there were no signs of flash, a perfect shield impervious to oxygen being formed over the wood and cloth.

This paint can be used to advantage for the preservation of wooden bridges and ties, especially in hot districts where they are so apt to be fired by sparks from a locomotive. The Rabok Manufacturing Co. of St. Louis, Mo., is the maker of this paint, and it seems to have kept up and anticipated great strides of progress and improvement. The paint was produced after years of experimenting to fill the wants of the government in the preservation of the gun carriages, wharfs, piers and submarine boats, where it is now being used.

Manganese Frog

The accompanying illustration shows the distorted manganese frog that was exhibited by the Indianapolis Switch & Frog Co. It was bent or distorted for the purpose of demonstrating the physical properties of the manganese used. This frog was subjected to 165 drops of a 1,250-lb. and 2,500-lb. weight for a distance ranging from 3 ft. to 23 ft. aggregating 1,679,375 ft. lbs., yet showing no fracture or impairment of any nature.



The Exhibit of Indianapolis Switch & Frog Co.

List of Exhibits

The following is a list of all exhibits at the Coliseum during the convention of the Railway Signal Association and the American Railway Engineering and Maintenance of Way Association, March 14-19, inclusive:

Adams & Westlake Company, Chicago.—Signal lamps, lanterns; railway specialties. Represented by W. H. Baldwin, G. L. Walters, H. G. Turney, A. S. Anderson, C. B. Carson, W. J. Pierson. Spaces 83 and 84.

Adreon Manufacturing Company, St. Louis.—Clark tension set tie plate, Security rail brace and tie plate. Represented by E. L. Adreon, Jr., and Wm. Miller. Space 109.

Advance Power Company, Chicago.—Inspection car. Represented by Mr. Warner. Space 215.

Alamo Manufacturing Company, Hillsdale, Mich.—Gasoline, gas, kerosene and distillate engines for railway service, pumping outlets, charging storage battery plants. Represented by L. A. Hopkins, J. L. Benedict, B. L. Winchell, Jr., R. A. Patterson, H. F. Worden, L. C. Thompson. Space 99.

Alexander Crossing Company, Clinton, Ill.—Continuous-rail, non-pounding crossings. Represented by M. J. Hinchcliff, C. R. Westcott, I. N. Brown. Spaces 204-5-8-9.

Allith Manufacturing Company, Chicago.—Approved fire-door; warehouse door; continuous parallel door; merchandise carrier. Represented by W. D. Jameson, W. C. Lang. Space 116.

American Concrete Company, Chicago.—Reinforced concrete pipe, piling and girders. Represented by O. J. West, G. H. Scribner, Jr., O. P. Scribner, D. S. Edwards. Space 15.

American Guard Rail Fastener Company, Philadelphia.—Anchor guard rail clamps, tie plate guard rail fasteners.



Manganese Frog.

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Vaughan automatic rail anchors. Represented by D. F. Vaughan, Chas. Z. Vaughan. Space 118.

American Hoist & Derrick Company, St. Paul, Minn.—Moving pictures, "American" railway ditcher, hoisting engines, etc. Represented by Frank J. Johnson, W. L. Manson, W. O. Washburn. Spaces 189, 190, and 191.

American Locomotive Company and Atlantic Equipment Company, New York and Chicago.—Photographs, catalogues and pamphlets of steam shovels, locomotives, dredges, rotary snow plows and automobiles. Represented by John H. Wynne, Ottis Parsons, Edwin M. Hall, A. M. Sheffer. Space 30.

American Rail Joint Company, Toronto, Canada.—Reinforced angle bars. Represented by Thos. D. Beddoe. Space 194.

American Railway Device Company, Chicago.—Track specialties, tool grinder attachment for handcars, anti-rail creepers. Economy separable switch points. Represented by O. Metcalf, Jr. Space 177.

American Railway Signal Company, Cleveland, Ohio.—Electric automatic signals; electric switch locks; electric dwarf signals; lower and switch indicators; relays and electric interlocking apparatus. Represented by G. L. Weiss, H. M. Abernethy, H. D. Abernethy, J. L. Burrows. Spaces 22 and 23.

American Railway Steel Tie Company, Harrisburg, Pa.—Combination steel and asphalt ties. Represented by John G. Snyder.

American Steel & Wire Company, Chicago.—Right-of-way fencing, rail bonds, triangle mesh concrete reinforcement, nails and wire, electrical wires, W. & M. telephone wire. Represented by B. H. Rider, H. S. Durant, R. C. Moeller, C. S. Knight, J. M. Holloway, L. P. Shanahan, H. A. Parks. Spaces 69-70 and 50-51.

American Valve & Meter Company, Cincinnati, Ohio.—Water service supplies, embracing Poage improved automatic water columns; tank valves and fixtures; float valves; Fanner drop spout; track devices showing the Economy switch stands; Anderson's safety switch lock. Represented by J. T. McGarry, F. C. Anderson, Burton W. Mudge. Spaces 130 and 131.

American Vulcanized Fibre Company, Wilmington, Del.—Vulcanized fibre for rail joint insulation. Represented by John Barron.

American Well Works, Chicago.—Deep well and centrifugal pumping machinery, with any style of power, air compressors, well drilling and prospecting machinery. Represented by Geo. W. Igo, C. O. McLean, A. W. McLean. Spaces 12 and 13.

Cortlandt F. Ames, Chicago.—Hercules bumping posts, manufactured by J. M. Scott & Sons, Racine, Wis.; Automatic lock nuts, manufactured by Automatic Lock Nut Company, Rockford, Ill. Represented by J. M. Scott, E. E. Scott, Chas. Rystrom, Cortlandt F. Ames. Space 115.

Arpspear Manufacturing Company, New York—Pressed steel switch lamps, one-day and long-time burners; semaphore and train order lamps; automatic classification and train markers; steel and wire guard lanterns. Represented by F. D. Spear, C. K. Freeman, F. A. Buckley. Space 184.

Asphalt Ready Roofing Company, New York.—Roofing materials, asphalt saturated felts. Represented by Birney Blackwell, C. A. Sparrowhawk, J. A. Sturges, H. D. Keeler. Space 168.

Atlas Portland Cement Company, New York.—Samples of Portland cement. Represented by P. Austen Tomes, D. H. MacFarland, E. D. Boyer, John Evans. Space 146.

Badger Brass Manufacturing Company, Kenosha, Wis.—Locomotive and interlocking headlights. Represented by W. A. Belle, R. H. Welles, W. L. Yule. Space 220.

Barker Mail Crane Company, Clinton, Ia.—Mail crane. Represented by L. W. Barker. Space 181.

Barrett Manufacturing Company, New York.—Roofing; bridge waterproofing with bituminous binder protection; floor construction particularly adapted for repair shops and freight houses. Represented by W. S. Babcock, L. P. Sibley, H. B. Nichols, C. T. Bilyea, W. J. Walker. Space 106.

Bausch & Lomb Optical Company, Rochester, N. Y.—Engineering and surveying instruments, transits, levels, etc. Represented by W. Louis Johnson, F. M. Storr, H. D. Skelton. Space 17.

Beaver Dam Malleable Iron Company, Beaver Dam, Wis.—Tie plates and rail braces. Represented by Lawrence Fitch, J. V. Cowling, F. S. McNamara, E. A. Hawks, W. L. Douglas, D. P. Lamoreux, A. E. Martin, E. M. Cowling. Space 166.

Bird, F. W., & Son, East Walpole, Mass.—Pariod roofing, building papers and waterproofing, roof paints, etc. Rep-



General View of Exhibits at Coliseum.

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The Exhibit of Spencer Otis Co.

resented by A. R. McAlpine, W. E. O'Neill, M. L. Caton, C. H. Martin. Space 2.

Bird, J. A. & W., & Co., Chicago.—Rex Plinkote roofing, signal, railroad roofing, Concrex roofing, Zolium tile roofing, Paradux canvas top roofing, Tunaloid waterproofing felt, insulating papers, roof and damp proof paints. Ripolin enamel paint. Represented by F. E. Cooper, H. W. Benedict, F. A. Dale, M. B. Hood, Howard Schofield, Paul L. Griffiths, C. E. Rahr. Space 140.

Blocki-Brennan Refining Co., Chicago.—Carboxide, elastic metal preserver. Represented by W. F. Brennan, J. A. Early. Space 169.

Bossert, W. E., Manufacturing Company, Utica, N. Y.—Triple-lock switch stand, Bossert insulated rail joint, Bossert improved switch point adjuster, tie plate and guard rail clamp, semaphore blade clasps, Reliance spike braces. Represented by F. L. Guillaume, H. C. Williams, Willis C. Squire. Space 137.

Bowser, S. F., & Co., Inc., Fort Wayne, Ind.—Oil storage systems, Bowser self-measuring pumps. Represented by C. A. Dunkleberg, W. T. Simpson. Space 16.

Bryant Zinc Company, Chicago.—Signal supplies, battery supplies, fiber conduit, storage batteries, crossing bells, battery vaults and chutes, electrical instruments, track and linemen's tools. Represented by E. M. Deems, R. N. Baker, Stanley Bryant, H. J. Hovey, A. F. Klink, R. N. Chamberlain, R. Parmlee, P. W. Herbst, J. W. Cremerius. Spaces 153-4-5-6.

Buda Company, Chicago.—Railway motor cars and velocipedes, track drills, drill grinders, switch stands, ratchet jacks, ball bearing jacks, adjustable switch rods, solid manganese crossing, replacers, electric crossing gates. Represented by H. K. Gilbert, L. M. Viles, Wm. P. Hunt, Jr., C. H. DeLano, W. B. Paulson, J. T. Harahan, Jr., Geo. B. Shaw, L. Hamill, A. R. Dyer, J. J. Gard, H. S. Evans, W. T. Smettem, W. E. Marvel. Spaces 87-88-89-90.

* Buff & Buff Manufacturing Company, Chicago.—Surveying

instruments. Represented by The Engineering Agency, A. G. Frost, D. E. Rossetter. Half of space 94.

Buyers' Index Company, Chicago.—Book "Purchasing Agents, Buying List and Railway Supply Index." Represented by Lloyd Simonson, D. J. Beaton, F. B. Cozzens. Space 112.

Card & McArdle, Waukegan, Ill.—Timber-treating engineers. Represented by J. B. Card. Space 221.

Philip Carey Company, Cincinnati, Ohio.—Roofing, asbestos and magnesia products, insulating materials. Represented by R. B. Murdock, E. S. Main, C. L. Cockrell. Space 170.

Carnegie Steel Company, Pittsburg.—Section of railroad track, constructed with steel crossties, Duquesne joints and 100-lb. American Society rail, with various types of fastenings, including wedge fastenings illustrated in Bulletin No. 108. General assortment of Duquesne rail joints for principal sections of standard rails; Schoen steel wheels, including a wheel having been worn in service representing 301,374 miles; nickel-plated samples, showing various types of U. S. and Friedestadt sheet piling. Represented by N. M. Hench, Edwin S. Mills, C. B. Friday, D. B. Coey, W. A. Bostwick, P. W. O'Brien, H. C. Griswold, Robt. Coe, A. R. Archer. Spaces 71-72-52-53.

Central Electric Company, Chicago.—General western agents for the Okonite Company, New York.—Okonite wires, aerial, lead covered and submarine cables, pot heads, joints, Manson and Okonite tapes, and samples of crude rubber. Represented by J. N. Lorenz, M. Cox, W. D. Dunsmore, D. M. Ayers, Lewis D. Martin, F. J. White. Spaces 203 and 210.

Channon, H., Company, Chicago.—Shovels, pumps, blocks, wheelbarrows and other railway supplies. Represented by O. W. Youngquist, Harry Keegan, B. Berntsen. Space 160.

Chicago Steel Tape Company, Chicago.—Steel tapes, leveling rods, lining poles, etc., for field use. Represented by L. A. Nichols, J. Levinson. Half of space 94.

Chicago Tie & Rail Fastening Company, Chicago.—Rail fast-



Exhibit of Pittsburg Steel Co.

nings, tie plates and concrete ties. Represented by Andrew Stark, Henry Bryant, Burt F. Fuller. Space 174. Cleveland Frog and Crossing Company, Cleveland.—"Hard Service" manganese frogs and crossings, improved spring rail frogs, switches, switch stands, guard rail clamps, Prentice anti-rail creepers, etc. Represented by G. C. Lucas, George Stanton, George A. Peabody, L. G. Parker, George Arnold, Jr. Spaces 102-3-4.

Izard-Warren Company, Inc., Philadelphia.—"Sterling" transits and levels, engineering and drawing materials. Represented by J. Henry Warren.

Clow, James B., & Sons, Chicago.—Plumbing, steam, water and foundry products. Represented by W. E. Clow, Jr., Yates A. Adams, W. T. Brace, J. L. Ponic, W. R. Plum, L. J. Elliott. Space 33.

Conley Frog & Switch Company, Memphis, Tenn.—Conley patent frog, manganese frogs, rail braces, railway track appliances. Represented by John E. Conley, Fred C. Taylor. Space 34.

Cook Standard Tool Company, Kalamazoo, Mich.—Jacks, track drills, drill grinders, bits. Represented by E. Cook, E. H. Edelmann. Space 183.

Coulter-Paxton Company, Hammond, Ind.—Track wrench, rail drill and bonding rail drill. Represented by W. G. Paxton, J. W. Paxton, C. J. Coulter. Space 172.

Crear, Adams & Co., Chicago.—Hercules steel warehouse trucks for handling portable articles, such as freight packages, barrels, boxes, etc. Represented by C. A. Roberts, F. R. Sheperd, P. J. Ford, Russell Wallace, J. A. Martin, C. W. Gregory, T. W. Bartlett, G. D. Bassett, G. B. Howard, R. M. Bullard. Space 95-96.

Detroit Graphite Company, Detroit, Mich.—Paint for bridges, buildings, structural steel, etc. Represented by T. R. Wyles, L. D. Mitchell, Edwin Booth, A. H. Kuerst. Space 167.

Detroit Hoist & Machine Company, Detroit.—Pneumatic and electric locomotive turn-table tractors. Represented by J. C. Fleming, F. B. Fleming. Space 191.

Paul Dickinson, Inc., Chicago.—Smoke jacks, cast iron chim-

neys and ventilators. Represented by J. A. Meaden, A. J. Filkins, E. W. Hodgkins, W. H. Dayton, Geo. M. Kenyon, F. C. Webb, F. W. Brydges. Space 186.

Eugene Dietzgen Company, Chicago.—A complete line of surveying instruments, leveling rods, ranging poles, tapes, rail profile machines, and other supplies which are used by engineers and surveyors both in the office and in the field. Represented by W. E. Cook, W. O. Phillips, O. S. Rhea. Space 97.

Dilworth, Porter & Co., Limited, Pittsburgh.—Railroad spikes, tie plates. Represented by W. F. Schleiter. Space 26.

Joseph Dixon Crucible Company, Jersey City, N. J.—Graphite paint, lubricating graphite, crucibles and plumbago. Represented by E. R. Smith, B. B. Worley, H. W. Chase. Space 117.

Dressel Railway Lamp Works, New York.—Switch lamps, semaphore lamps, tower lamps, station lamps, engine lamps, tail marker lamps, caboose lamps, crossing gate lamps. Represented by Robert Black, E. W. Hodgkins, F. W. Edmunds, A. P. Grenier, W. H. Dayton. Space 5.

G. Drouve Company, Bridgeport, Conn.—Anti-Pluvius putty-less skylights and sash operators, "Lovell" and "Straight Push." Represented by William V. Dee, George J. Adams, R. S. Adam, A. H. Bates. Space 158.

Duntley Manufacturing Company, Chicago.—Rockford gasoline section and inspection cars, Rockford track weeder, Duntley pneumatic cleaners. Represented by L. C. Thompson, H. F. Worden, J. G. Minert, E. J. Cornish, R. A. Patterson, B. L. Winchell, Jr., Geo. M. Kenyon. Spaces 81 and 100.

Duplex Metals Company, New York.—Copper clad steel wire, model of coating process and material in various stages of manufacture; samples of all kinds. Represented by Frank R. Chambers, Jr., James F. Kinder, Wirt Tassin, George Wolf, W. T. Kyle, Geo. B. Muldaur, Jas. A. Waugh. Spaces 38 and 39.

Eastern Granite Roofing Company, New York.—Granite roofing, Evertite crushed stone roofing, Tisbest smooth sur-

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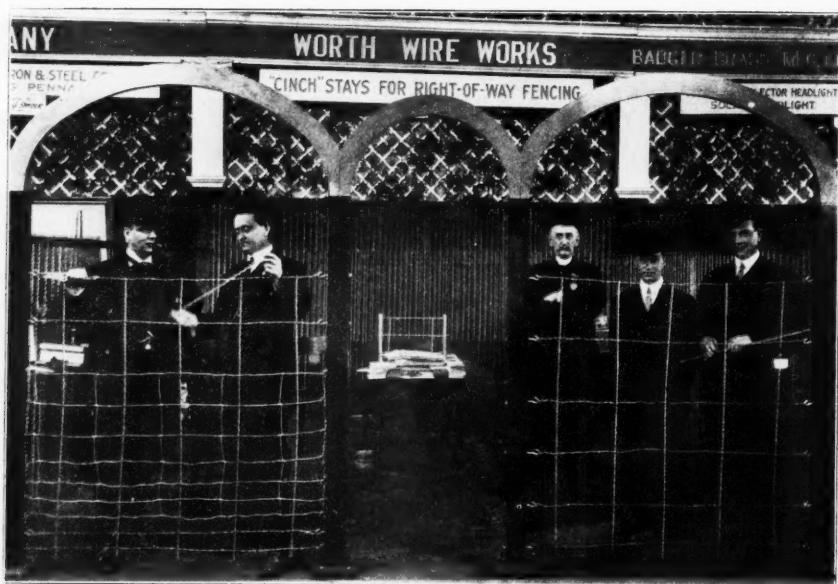


Exhibit of Worth Wire Works.

face roofing. Represented by H. Henning, P. G. Kennett, A. W. Turner, C. F. Barstow. Space 129.

Economy Separable Switch Point Company, Inc., Louisville, Ky.—“Mitchell” and “Palmer” types separable switch points; Economy separable claw bars. Represented by W. M. Mitchell, W. M. Mitchell, Jr., B. B. Betts. Space 187.

Edison Manufacturing Company, Orange, N. J., and Chicago.—B. S. C. O. and Edison primary batteries for signal work, automatic block signals, crossing bells. Represented by E. E. Hudson, F. J. Lepreau, E. W. Brown. Space 151. O. M. Edwards Company, Syracuse, N. Y.—Railroad padlocks and railway devices. Represented by C. H. Rockwell, Russell Hotchkiss. Space 150.

Electric Storage Battery Company, Philadelphia.—“Chloride Accumulator” batteries for drawbridge operation and “Chloride,” “Tudor” and “Exide” types for car lighting, signal, interlocking and automatic block signal work. ET. couple types for small lighting plants and telegraph service. Represented by G. H. Atkin, T. Milton, R. I. Baird, T. A. Cressey. Space 149.

Fairbanks, Morse & Co., Chicago.—Motor cars, standpipes, pumping machinery, dynamos, drills, scales, etc. Represented by A. A. Taylor, C. W. Kelley, R. E. Derby, L. H. Matthews, F. M. Condit, F. H. Clark, C. D. Walworth, R. D. Head, F. F. French, F. E. Church, H. C. McClary, S. F. Forbes, J. G. Jones, J. A. Steele, E. M. Fisher, L. Norvell, F. B. Roy, A. F. Young, H. D. Smith, A. C. Dodge, F. H. Douglas. Spaces 35-6-7 and 54-5-6.

Federal Signal Company, Albany, N. Y.—Electrical and mechanical signaling and interlocking apparatus. Represented by J. T. Cade, A. Dean, Jr., H. H. Cade, W. H. Reichard. Space 93.

Ford & Johnson Company, Chicago.—Line of Perfection railroad seats and chairs for parlor and buffet cars. Also rattan seating. Represented by Benjamin H. Forsyth, Walter J. Bennet, Clarence A. Van Derveer. Space 159.

Frank M. Foster, Columbus, Ohio.—Foster interlocking switch stands with independent facing point lock and distant signal operated with one movement of one lever. Represented by Frank M. Foster, George E. Kalb. Space 138. Franklin Manufacturing Company of Pennsylvania, Franklin, Pa.—Asbestos reinforced corrugated roofing or siding, as-

bestos “Century” shingles, asbestos building lumber and asbestos lumber smoke jacks, asbestos pipe coverings, Chapman circular glass cutter. Represented by R. J. Evans, E. R. Rayburn, L. B. Melville, F. S. McNamara, John G. Sanborn. Space 6.

Thomas A. Galt, Sterling, Ill.—Steel-cushioned railroad tie. Represented by J. W. Hatch, E. W. Aument, E. L. Galt, Thomas A. Galt. Space 224.

General Railway Signal Company, Rochester, N. Y.—All electric interlocking machines, electric switch movements, various types of power signals, automatic signals, manual control signals, relays and other such devices. Represented by W. W. Salmon, L. Thomas, W. K. Howe, Geo. D. Morgan, F. L. Dodgeson, M. R. Briney, J. L. Langdon, H. M. Sperry, M. Wuerple, C. O. Poor, J. B. Evans, G. W. Macdonough, W. R. Young, F. H. Jones. Spaces 57-8-9-60.

Goheen Manufacturing Company, Canton, Ohio.—Preservative coatings for iron and steel. Represented by A. W. Price, G. L. Clapper. Space 109.

Peter Gray & Sons, Inc., Boston.—Railroad lamps and lanterns. Represented by Geo. M. Gray, J. M. Brown. Space 175.

Greenlee Bros. & Co., Chicago.—Railway tie boring, plugging and facing machines (Kendrick patents), screw spike driving machines. Represented by J. A. Lounsbury, O. V. Haegg. Space 7 and 8.

Grip Nut Company, Chicago.—Grip nuts, special grip holding nuts. Represented by E. R. Hibbard, Herbert Green, B. L. McClellan, W. G. Wilcoxson, B. C. Wilt, R. A. Flum, B. J. Bernhard, J. W. Hibbard. Space 40 and 41.

Hall Signal Company, New York.—Railway signals and accessories. Represented by W. J. Gillingham, Jr., W. H. Lane, W. G. Hovey, H. L. Hollister. Space 80.

Handlan-Buck Manufacturing Company, St. Louis.—Lamps, lanterns, long-time burners, Cairncross train indicators, track tools, McPartland rail clutches, metallic slow flags, and metallic train flags. Represented by A. H. Handlan, Jr., R. L. Cairncross, E. W. Handlan. Space 125.

Hart Steel Company, Elyria, Ohio.—Railroad tie plates and standard spikes. Represented by W. S. Miller, W. T. Bentz, Willis McKee, G. S. Wood, A. W. DeRocher, H. W. Davis, J. M. Van Harlingen. Space 101.

Hayes Track Appliance Company, Geneva, N. Y.—Hayes derails and attachments. Represented by S. W. Hayes, W. Harding Davis, Wellington B. Lee, Arthur Gemunder, K. M. Thompson, S. W. Wallace. Space 139.

Heath & Milligan Manufacturing Company, Chicago.—Siding finished with Way & Station paint and panels decorated with Durotene, a new and unique paint which dries absolutely flat, with a velvet-like, soft finish, which is sanitary and waterproof, and at the same time possesses unusual wearing qualities. Also a brineproof paint and rust inhibitive; paints and finishes for all seam and electric railway painting purposes. Represented by A. M. Heath, B. H. Pinkerton, J. H. Vance, C. R. Arnold, J. B. Campbell. Space 179.

Hobart-Allfree Company, The, Chicago.—Smyth and Free-lan deraillers; Newton car replacers. Represented by E. H. Allfree, W. H. England, Frank P. Smith. Space 148.

Hoskins Rail Chair Company, Chicago.—The Hoskins Combined Rail Joint and Chair. Represented by Zachary T. Hoskins, N. L. Towle. Space, half of 198.

James O. Heyworth, Chicago.—Three-yard bucket of the Heyworth-Newman excavator. Represented by H. N. Elmer, R. A. Meredith.

Interlocking Nut & Bolt Company, Pittsburgh.—The Clark nut lock, as applied to track bolts; frog and crossing bolts; steel tie bolts, bolts for interlocking work, track bolts for cars. Represented by R. A. Clark. Space 185.

H. W. Johns-Manville Company, New York.—Asbestos and magnesia materials, electrical supplies, roofings, smoke jacks. Represented by J. E. Meek, J. C. Younglove, F. M. Gilmore, C. E. Murphy, H. A. Waldron, J. M. Trent, P. C. Jacobs, G. W. Ristein, Jr., R. A. Hamaker, H. G. Newman, H. T. Morris. Space 144.

O. F. Jordan Company, Chicago.—The Jordan earth and ballast spreader and snow plow combined. Represented by M. J. Woodhull. Space 181.

Kalamazoo Railway Supply Company, Kalamazoo, Mich.—Manufacturers of hand, push and velocipede cars, improved track drills, jacks, pressed steel wheels, crossing gates and other track appliances. Represented by John McKinnon, Chas. B. Hays, Frank B. Lay, C. A. Wallace, Donald A. Stewart, Geo. W. Mingus, W. I. Clock, H. C. Wilson. Spaces 24 and 25.

Joyce-Cridland Company, Dayton, Ohio.—Hydraulic and all other types of jacks. Represented by F. I. Joyce, George W. Llewellyn, N. Kohl, C. F. Palmer, Edwin Romeiser. Space 77.

W. K. Kenly Company, Chicago.—Security anchor tie plate, Gump ear replacer, Latimer switch point lock, Universal carrier base, Arctic water box, Manhattan compromise joint, Moore trick drills, Kalamazoo velocipedes. Represented by A. P. Van Schaick, W. J. Fauth, Gerard Van Schaick. Spaces 78-79.

Kennicott Water Softener Company, Chicago Heights, Ill.—Water softening machinery. Represented by Cass L. Kennicott, Edwin J. Flemming, Frank S. Dunham, T. J. Windes. Space 74.

Kerlin Automatic Post Machine Company, Delphi, Ind.—Cement post machine; reinforcement for concrete post and concrete railroad tie. Represented by Wm. F. Kerlin, E. W. Bowen, E. R. Smock, Rega Porter, Wm. Donlin, R. C. O'Connor, W. A. Eldridge, Roy Kennedy, S. Benefield. Spaces 211-212-213.

Kerite Insulated Wire & Cable Company, New York.—Kerite insulated wires and cables. Represented by Azel Ames, P. W. Miller, J. V. Watson, B. L. Winchell, Jr., R. A. Paterson, E. B. Price, J. A. Renton. Spaces 61 and 62.

Keystone Driller Company, Chicago.—One large size double-stroke geared pump head for deep wells; plungers, working barrel, one model double-stroke, geared pump in op-

eration; also catalogue of deep well drilling machinery. Represented by E. O. Eyer, R. M. Downie. Space 188.

Kueffel & Esser Company, New York and Chicago.—Drawing materials, surveying instruments, drawing instruments, measuring tapes, etc. Represented by Rudolph Link, G. C. Moore. Space 98.

Lackawanna Steel Company, New York.—Rails, rail joints, structural and bridge material, reinforced concrete bars, steel sheet piling and track supplies. Represented by C. R. Robinson, G. A. Hagar, C. H. Hobbs, Blythe Harper. Spaces 31 and 32.

Lehon Company, Chicago.—Roofings, waterproofings and paints; manufacturers Roofite roofing with over-seal lap; Roofite car and cab roofing; Roofite waterproofed canvas for passenger cars; Roofite sill covering; mule-hide rubber roofing; Dry-Art insulating paper; Polar-Bear insulating paper; Lehon's duplex refrigerator felt; Niagara waterproof paper; Roofine paint; Damptite waterproofing compound. Represented by Tom Lehon, John T. Sullivan, C. E. Rice. Space 220.

Lidgerwood Mfg. Co., Chicago.—Incline car hoist. Represented by Frank D. Knight, W. G. Wilmot. Space 196.

Link-Belt Co., Chicago.—Elevating and conveying specialties as applied to the handling of coal, freight, etc., by railways; photographs, printed matter, etc. Represented by J. C. Nelligar, W. W. Sayers, R. C. Turner. Space 128.

Lufkin Rule Company, Saginaw, Mich.—Measuring tapes of all descriptions; steel rules, etc. Represented by Theo. Huss, S. B. McGee, B. F. Gould, F. G. Brown. Space 121. Lutz-Lockwood Manufacturing Co., Aldene, Union Co., N. J.—Lutz primary cells (disc type), Gordon primary cells and "SX" ignition dry cells. Represented by W. M. Kinch, Geo. Marloff. Space 133.

David Lupton's Sons Company, Philadelphia.—Lupton steel sash; Lupton rolled steel skylight; Pond operating device; Pond continuous sash. Represented by Clarke P. Pond, George P. Heinz. Space 92.

Mackenzie-Klink Publishing Co., Chicago.—The Signal Engineer; The Signal Directory; Railway Electrical Engineer; Modern Machinery. Represented by L. B. Mackenzie, A. F. Klink, A. D. Cloud, Edward Wray, Edward Hammond, J. P. Sharpe, C. E. Gould, Fred W. Bender. Space 136.

Indianapolis Switch & Frog Company, Springfield, Ohio.—Manganese frogs, crossings, switches, etc. A special showing of I. Sw. & F. Co. Model R-N-R manganese frogs and tests. Represented by E. C. Price, W. H. Thomas, W. L. Walker, T. D. Hanley, G. S. Shaw, J. A. Foulks. Space 182.

Manganese Steel Rail Company, New York.—Manganese steel products, consisting of rails, sheets, plates and forgings. Represented by F. W. Snow, Sumner T. McCall, Oakley W. Cooke, E. Payson Cooke, W. S. Potter, F. C. Stowell, J. R. Aiglettinger.

Mann McCann Co., Chicago.—Graders, spreaders, snow plows, smoke jacks, track movers, flue rattlers, ventilators, etc.; The Mann No. 3 Universal machine. Represented by O. C. Mann, L. C. Mann. Space 176.

C. F. Massey Company, Chicago.—Railway signal materials, Massey battery wells. Represented by C. F. Massey, Wm. H. Powell, R. J. Collins, E. J. Relph. Space 134.

W. N. Matthews & Brother, St. Louis.—Matthews guy anchors, telephone jack boxes and plugs for dispatching systems, cable clamps, cable splicing joints, lamp guards, and other money saving specialties. Represented by Clause L. Matthews, W. N. Matthews, Victor L. Crawford, Walter E. Bichoff. Space 142.

Alexander Milburn Co., Baltimore, Md.—Portable lights. Represented by A. F. Jenkins, Benj. Surjeek. Space 216 Annex.

Morden Frog & Crossing Works, Chicago.—Unity switch stand operating distant signal and facing point switch with positive point lock. Parallel ground throw, G. L. M. switch

RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

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stand, rigid manganese steel frogs; guard rail clamps; switch adjustments; rail braces; slide plates; track jacks; compromise joints, etc. Represented by Arthur C. Smith, H. M. Macke, D. H. Cusic, W. J. Morden. Space 86.

Morgan Frog & Crossing Co., St. Louis.—Continuous rail boltless frog. Represented by B. J. Morgan, G. H. Kelley. Space 192, Annex.

Burton W. Mudge & Company, Chicago.—Adams motor car, safety mail crane. Represented by Burton W. Mudge, C. M. Mudge, Geo. E. Simmons, Otto P. Hennig, W. E. Adams. Spaces 113-114.

Municipal Engineering & Contracting Co., Chicago.—Chicago improved cube concrete mixer. Represented by C. E. Bathrick. Space 19.

National Electric Specialty Company, Toledo, O.—Space 223. Annex.

National Lock Washer Company, Newark, N. J.—Nut locks. Represented by F. D. Archibald, G. E. Baker, F. B. Buss, John B. Seymour. Space 124.

National Malleable Castings Company, Cleveland.—Malleable track specialties. Represented by F. R. Angell, H. L. Hiatt, J. J. Byers. Space 145.

National Roofing Co., Tonawanda, N. Y.—Mineral asphalt roofing; gravel and feldspar surfaced; asphalt roof coating; asphalt paints; graphite paints; slack paint and metal protecting paints. Represented by O. H. Dean, A. E. Armbuckle, D. A. Bonitz, H. R. Sennett. Space 195.

Geo. P. Nichols & Bro., Chicago.—Electric turntable tractor and drawbridge specialties; also photographs of transfer tables, turntable tractors and drawbridge installations. Represented by Geo. P. Nichols, S. F. Nichols. Space 173.

O. K. Nut Lock Co., Providence, R. I.—Bolts of all kinds equipped with O. K. Nut Lock. Represented by John R. Armstrong. Space 222, Annex.

Ohio Post Mold Company, Toledo, Ohio.—One six-post machine, two six-post machines designed for steam curing kilns. Several posts. Represented by E. S. Smith, A. M. Smith. Space 201.

Okonite Company, New York.—Central Electric Co., Chicago, general western agents: Okonite wires, aerial, lead covered and submarine cables, pot heads, joints, Manson and Okonite tapes and samples of crude rubber. Represented by Lewis G. Martin, F. J. White, J. M. Lorenz, M. Cox, W. D. Dunsmore, D. M. Ayers. Spaces 203-210.

Spencer Otis Company, Chicago.—Economy railway tie plates. Represented by W. L. DeRemer, H. H. Hart, Carter Blatchford. Spaces 122 and 141.

Otto Gas Engine Works, Chicago.—Coal chute machinery and spouts, guard rail clamp, gasoline engines. Represented by T. W. Snow, R. E. Gurley, H. C. Harnish, C. C. Lazenby, R. A. Ogle. Spaces 49 and 68.

Pacific Timber Preservative Company, Spokane, Wash.—Treated cross-ties, telephone and telegraph poles and fence posts. Comparison of results in actual track service. Represented by Robert E. Allen. Space 11.

W. W. Patterson Company, Pittsburgh.—Double extra heavy wood tackle blocks for manila rope; double extra heavy steel tackle blocks for wire cables. Represented by W. W. Patterson, Jr. Space 147.

C. F. Pease Co., Chicago.—Automatic blue and white print machinery and engineering and drafting room supplies, consisting of automatic equipments for printing, washing and drying both blue prints and direct white prints by one continuous operation; also trimming tables and other blue print apparatus, as well as a full line of Sterling engineering transits, levels, etc. Represented by C. F. Pease, P. M. Morgan. Spaces 161 to 164, inclusive.

Pennsylvania Steel Company, Steelton, Pa., and Maryland Steel Company, Sparrows Point, Md.—Solid Manard crossing No. 40; Manard anvil face frog, design 160, section No. 235; No. 10 solid Manard frog, section No. 235; No. 10 spring rail frog, design 278, section No. 235; sample Never-Turn split bolt; Never-Slip slide plate; New Process switch with rolled Manard (improved manganese) stock rail; intermediate main line safety switch stand, Model 56-B; low New Century switch stand, Model 51-A; low Steelton positive switch stand, Model 52-A; intermediate New Century switch stand, Model 50-E, with semaphore attachment; rolled Manard (improved manganese) rails—solid cast Manard frogs. Represented by C. W. Reinoehl, B. L. Weaver, G. S. Vickery, Wm. M. Henderson, N. E. Salsich, Robert E. Kelknap, H. F. Martin, J. C. Jay, Jr., C. S. Clark, R. M. Lechthaler, Drew Allen, W. H. Allen, M. L. Long, H. G. Barbee, J. W. Hennessey, C. F. Rolland. Spaces 45-6-7-8 and 64-5-6-7.

Pittsburg Steel Company, Pittsburg.—"Pittsburg Perfect" fencing for railroad right-of-way. Represented by W. R. Marsh, E. D. Finlay, E. Steytler. Space 197.

Pocket List of Railroad Officials, New York.—Pocket List of Railroad Officials. Represented by J. Alexander Brown, Chas. L. Dinsmore. Space 26.

D. & A. Post Mold Co., Three Rivers, Mich.—"D. & A." concrete post machinery and molds; specimens of reinforced cement posts; also sections of same showing construction, materials used; also different methods of reinforcement, as applied to the farm, vineyard and railway use. Represented by G. H. Dougherty, L. R. Dougherty, O. Dougherty. Space 132.

Potter-Winslow Company, Chicago.—Reinforced concrete battery vaults, concrete battery chutes, storage battery containers, concrete foundations, concrete posts and signs. Represented by Frank H. T. Potter, A. C. Heidelberg, W. R. Potter. Space 185.

Q. & C. Company, New York.—Bonanzo joints; step joints insulated joints, anti-rail creepers, rail saws, rail benders, guard rail clamps, guard rail braces, rail braces, castings, bolts and nuts, cement and metal ties. Represented by C. F. Quincy, G. C. Isbester, Geo. L. Hall, T. B. Bowman, J. V. Wescott, J. A. Bodkin. Spaces 119-120.

Rail Joint Company, New York.—Continuous Wever and Wolhaupter types, base supporting rail joints. Represented by V. C. Armstrong, L. F. Braine, W. E. Clark, J. A. Greer, Percy Holbrook, H. C. Holloway, J. G. Miller, F. A. Poor, E. L. Vandresar, B. Wolhaupter, F. C. Webb, E. A. Condit, Jr., S. J. Collins. Space 82.

Railroad Fence Works, Chicago.—Railroad fencing. Represented by E. G. Fisher. Space 165.

Railroad Supply Company, Chicago.—Tie plates, derailed signals. Represented by E. H. Bell, C. P. Cogswell, Jr., M. J. Comerford, E. W. Vogel, A. H. Smith, G. W. Davis, H. M. Bulk, W. H. Dayton, Frank C. Webb. Space 85.

Railway and Engineering Review, Chicago.—Represented by Willard A. Smith, Walter M. Camp, Clyde F. Burns, J. M. Lammedee, Paul R. Brooks, A. E. Hooven, G. E. Ryder, P. G. Stevens, Harold A. Smith. Space 20.

Railway Age Gazette, Chicago.—Railway Age Gazette, Daily Railway Age Gazette and standard railway publications. Represented by Edward A. Simmons, Ray Morris, Samuel O. Dunn, Lucius B. Sherman, John N. Reynolds, Frank S. Dinsmore, Cecil R. Mills, Bradford Boardman, William Forsyth, George L. Fowler, Francis E. Lister, H. H. Simmons, Henry Lee, William E. Hooper, Francis W. Lane, S. H. Ankeney, T. E. Crossman. Spaces 44 and 63.

Railway List Co., Chicago.—The Monthly Official Railway List, Railway Master Mechanic, Railway Engineering and Maintenance of Way. Represented by Wm. E. Magraw, C. S. Myers, C. C. Zimmerman, G. Miller, L. F. Wilson, N. F. Rehm, O. N. Middleton. Space 112.

Railway Specialty & Supply Co., Chicago.—P. & M. rail anchors, arc damp lightning arresters; photographs showing effect of rail creeping, signal accessories. Represented by

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Philip W. Moore, L. W. Kent, A. G. Rockwell, F. A. Preston. Space 105.

Rampo Iron Works, Hillburn, N. Y.—Automatic safety switch stands; manganese pointed switches; manganese center frogs, rolled manganese steel rail, etc. Represented by F. W. Snow, Arthur Gemunder, W. B. Lee, W. C. Kidd, F. C. Stowell, Jas. B. Strong. Spaces 91 and 110.

Roberts & Schaefer Co., Chicago.—Working model of Holmen-Barrett coaling station, working model of Sauerman Siamese coal breaker, and enlargements of photographs of various types of coaling stations. Represented by Edward E. Barrett, Clyde P. Ross, Hiram F. Post, James S. Shannon. Space 73.

St. Louis Steel Foundry, St. Louis.—Solid manganese steel frogs, crossing and inserts for steam and electric railways. Represented by J. H. Steedman, J. N. Maher. Space 3 and 4.

Scherzer Rolling Lift Bridge Company, Chicago.—Models, photographs, designs, plans, drawings, and literature. Represented by A. H. Scherzer, C. L. Keller, J. I. Vincent, J. T. Dickerson, W. F. Martin, H. D. Harting, R. W. Flowers. Space 178.

Sellers Manufacturing Company, Chicago.—Tie plates, angle bars, "Sellers Anchor Bottom Tie Plate." Represented by J. M. Sellers, J. T. Markman, L. S. Gordon. Space 123.

Standard Asphalt & Rubber Co., Chicago.—Sarco products and Sarco methods for water proofing concrete surfaces. Represented by W. H. Lawrence, R. E. Kartack. Space 1.

Strauss Bascule & Concrete Bridge Company, Chicago.—Drawings and models of Strauss trunnion bascule bridges. Space 157.

Strauss Self-Balancing Window Company, Chicago.—Drawings and models of Strauss self-balancing windows for buildings, cars, vessels, etc. Space 157.

Strobel Steel Construction Company, Chicago.—Models of bascule bridges, photographs of bridges, center of locomotive turntables. Represented by Theodore Rall, J. C. Holland, E. Haupt. Space 180.

Streeter-Amet Weighing & Recording Company, Chicago.—Automatic weight recording machine for railroad track scales for weighing carload shipments and automatic quick weighing dial attachment for freight warehouse and baggage scales for weighing L. C. I. freight. Represented by Fred Cruikshank, Fred H. Nemitz, Geo. Goetz, Chas. Gordon. Spaces 199 and 200, Annex.

Templeton, Kenly & Co., Ltd., Chicago.—Simplex track and car jacks. Represented by A. E. Barron, J. H. Hummel, W. B. Templeton. Space 126.

Union Fibre Company, Winona, Minn.—Linofelt insulating quilt for covering ice house, Linofelt sound deadening quilt for office buildings and other structures, waterproof lith board for insulating ice houses and cold storages; refrigerator Linofelt for insulating refrigerator cars. Represented by F. J. Bingham, S. E. McPartlin, W. H. Leeds, J. H. Bracken. Space 171.

Union Switch & Signal Co., Swissvale, Pa.—Interlocking and signaling apparatus for steam and electric railways, including electro-pneumatic and electric interlockings in operation; signals, relays and other apparatus for A. C. or D. C. automatic block signaling; staff system and other controlled manual apparatus; electric crossing gates and bells; Keystone insulated rail joints; mechanical interlocking details, etc. Represented by H. G. Prout, J. G. Schreuder, J. S. Hobson, S. G. Johnson, J. P. Coleman, M. D. Hanlon, L. F. Howard, T. H. Patenall, W. H. Cadewallader, J. D. Taylor, H. McCready, W. E. Faster, George Blackmore, W. M. Vandersluis, C. C. White, H. S. Beakes, E. T. Barnes. Space 42-43.

U. S. Metal & Manufacturing Co., New York.—"Diamond tapered steel poles; Wolfe automatic rail joint lock; Columbia lock nuts. Represented by B. A. Hegeman, Jr., F. C. Dunham, H. A. Hegeman, Arthur Masters. Space 18.

U. S. Wind Engine & Pump Co., Batavia, Ill.—Water columns, tanks, tank fixtures, steel substructures (all in model); switch stands. Represented by L. E. Wolcott, A. J. Anderson, C. E. Ward. Space 111.

Wm. Wharton, Jr., & Company, Inc., Philadelphia, Pa.—Manganese steel switches, frogs, crossings, and movable points, switch stands, guard rail clamps, anti-creepers, models, photographs, etc. Represented by V. Angerer, L. R. Ashurst, Jr., R. C. McCloy, W. B. Cooke, W. McLain, Arthur S. Partridge. Spaces 9-10-27-28 and 29.

Weir & Craig Manufacturing Co., Chicago.—Electric turntable tractors; compressed air turntable tractors; electric portable hoists; compressed air portable hoists; locomotive drop pit jacks (pneumatic and hydraulic). Represented by Fred G. Whipple, R. W. Young, J. D. Granville, H. B. Shreve. Space 143.

Weisell Nut Lock Company, Chicago.—A nut lock in the form of a lock nut, which depends upon a wedge principle. It follows the thread of the bolt into the head of the nut, operating as a wedge-fulcrum. Represented by C. J. Grady, S. Glenn Andrus, T. Turner. One-half of space 201.

C. H. Whall & Company, Boston.—"Whall's Special Railroad Fibre" for insulating rail joints, etc. and fuses for train protection. Represented by F. R. Whall, John B. Given. Space 127.

Winans Improved Patent Rail-Joint Co., Portland, Ore.—A base supported rail joint. Represented by Audubon Winans. Space 185½.

Winters-Coleman Scale Company, Springfield, Ohio.—Automatic weighing machinery; Osgood and Sonander systems. Represented by Randolph Coleman, H. B. Osgood, C. F. Byerly. Spaces 107 and 108.

Worth Wire Works, Kokomo, Ind.—Demonstrating the application of the "Cinch" fence stay, as used on railroad right-of-way fencing, to keep the line wires from spreading or sagging, at a minimum number of posts. Represented by O. H. Buck, W. N. Hall, F. Craig. Space 219.

Lewis Wylder, Cathay, N. D.—Models in reinforced concrete and metal railway ties. Represented by Lewis Wylder. Space 221.

Yale & Towne Manufacturing Co., New York.—Triplex blocks, padlocks, door checks. Represented by R. E. Gedney, C. H. VanWinkle, D. A. Wright, R. Kleinsmid, H. R. Butler. Space 152.

James Walker, consulting engineer of the Metropolitan West Side Elevated Railway at Chicago, has been appointed chief engineer, with office at Chicago.

The office of Roadmaster of the Rock Island Line at LeCompte, La., has been abolished. M. J. Farrell has been appointed Roadmaster between Eldorado, Ark., and Eunice, La.

R. P. C. Sanderson, superintendent of motive power of the Virginian Railway at Norfolk, Va., has resigned to become general superintendent of the new works of the Baldwin Locomotive Works at Eddystone, Pa.

T. H. Hamill, roadmaster of the National Railways of Mexico at Torreon, Coahuila, Mex., has been appointed resident engineer in charge of betterments and additions on the Northern division, with office at Monterey, Mex.

C. M. Tritsch, recently appointed superintendent of motive power and car departments of the Western Maryland, with office at Hagerstown, Md., has been appointed also to the same position on the Georges Creek & Cumberland Railroad.

E. W. Pratt, assistant superintendent of motive power and machinery of the Chicago & North Western, at Chicago, has been transferred to Clinton, Iowa. F. S. Fosdick, master mechanic at Mason City, Iowa, has been transferred to Chicago, succeeding E. H. Wade. J. Charlton, master mechanic at Chicago Terminal, Chicago, succeeds Mr. Fosdick, and W. R. Smith succeeds Mr. Charlton. E. B. Hall has been appointed a master mechanic, with office at Eagle Grove, Iowa, succeeding C. Coleman.

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J. F. Deems, general superintendent of motive power, rolling stock and machinery, of the New York Central Lines, with office at New York, has had his authority extended over the Toledo & Ohio Central and the Zanesville & Western.

C. S. Millard, engineer maintenance of way of the Cleveland, Cincinnati, Chicago & St. Louis at Indianapolis, Ind., has been appointed engineer of track and roadway, with office at Cincinnati, Ohio. As has already been announced, W. B. McLoughlin, engineer maintenance of way at Mattoon, Ill., succeeds Mr. Millard. Joseph Mullen, engineer maintenance of way at Mt. Carmel, Ill., succeeds Mr. McLoughlin. A. S. More, engineer maintenance of way at Wabash, Ind., succeeds Mr. Mullen, and W. C. Kegler succeeds Mr. More. A. Maischaider, assistant engineer on the St. Louis division (of the Cleveland, Cincinnati, Chicago & St. Louis) has been transferred to the Chicago division, and Thomas Steiner, assistant engineer on the Cairo division, succeeds Mr. Maischaider.

Automatic Safety Switch Lock

The Anderson Automatic Safety Switch Lock.—This switch lock can be applied to any main line switches of the high or skeleton type, making it possible to "interlock" the entire line. It prevents the operator from locking the switch unless it is

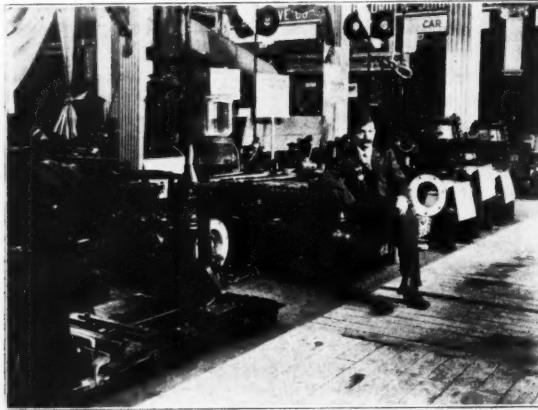


Exhibit of American Valve & Meter Co., Showing Anderson Economy Switch Stand.

properly closed, and prevents the switch from opening under traffic if the switch stand should be knocked down or improperly engaged with the switch, thus giving absolute safety on all facing point switches.

The Economy Switch Stand can be ordered with the safety switch lock if desired for places where high stands can not be used.

W. C. Brown on Government Regulation

"The relations of the road with its patrons and the communities served by it have been harmonious and pleasant. This mutually satisfactory condition has been fostered and encouraged by the efforts of the Public Service Commission in New York state and the Massachusetts board of railroad commissioners, in composing and adjusting differences which, handled with less wisdom and moderation, might have resulted in serious friction and controversy. The influence and the co-operation of these commissions have been uniformly beneficial to the road, and have done much to improve the service for the public. Does not this very desirable result emphasize the advantage of appointing to positions so vitally affecting every business interest of the country, men qualified by experience, temperament and ability to discharge the important duties of their office? Governmental regulation of railroads, within proper limitations, is of benefit to the public, to the railroads and to those who hold their securities; but, in order to secure the maximum benefit for all interests, it is important that natural

breadth and ability, and in addition thereto a willingness to undertake the conscientious, painstaking study of conditions necessary to enable them to deal intelligently with the complex and delicate questions affecting transportation that are constantly arising. General conditions were never more favorable, and every visible indication points to renewed and increasing prosperity for the country at large, in which the railroads may hope to participate."

*From the annual report of the New York Central, W. C. Brown, president.

Meeting of Ry. Signal Association.

(Continued from page 177)

handling or attention every month or so. Mr. Beck replied that careful investigation showed no practical difference in the labor bill of the two systems.

Mr. Eck brought out the point that cost is not only less, but by purchasing power a good many troubles are avoided which are bound to develop in charging from independent plants.

Mr. McKeen, signal engineer of the Oregon Short Line, described his method of handling storage battery with a charging car, covering about 160 miles per month, where there are an average of two signals per mile. This car is moved from point to point by the local freight train.

Mr. McKeen said that his signal maintainers test the storage batteries twice a week. The signal failures from dead batteries are very few, amounting to less than 1 per cent of all failures.

The next paper was by Messrs. Frank Rhea and E. E. Kimball, of the General Electric Co., entitled "The Generation Control and Transmission of Alternating Current for Railway Signals."

The discussion consisted mainly of a debate on technicalities between the authors, Mr. Howard of the Union Switch & Signal Co. and Mr. W. K. Howe of the General Railway Signal Co.

Mr. H. K. Weld, of the McRoy Clay Works, made some remarks on conduits for alternating current circuits.

New Literature

The Rockwell Furnace Co. of New York has issued catalogue No. 8 dealing with forge shop furnaces, operating on oil or gas fuel.

* * *

The 1910 "Blue Book" of the Scully Steel & Iron Co., Chicago and New York, is a well gotten up catalogue of all the "Scully" products and is worthy of a place on the desk of any person interested in them. It is about 4½x7 inches in size and is bound in a flexible, blue leather cover, making it very convenient as a book to be carried in the pocket.

* * *

Fairbanks-Morse & Co. of Chicago has recently put forth two very attractive catalogues descriptive of the marine engines manufactured by this company. Catalogue 112B deals with the heavy duty, four-cycle type, while catalogue 113 takes up the two-cycle engine. The latter engine is especially adapted to launches and power boats and is built with from one to six cylinders. The heavy duty engine is a very carefully built and tested engine and is reliable to a high degree.

ERRATA.

The photograph of Mr. J. M. Lorenz on page 110 in the March issue of this paper bore this caption: Okonite Representative, Century Electric Co. We wish to apologize to Mr. Lorenz for this error. He is the Okonite man of the Central Electric Co., Chicago, Ill.



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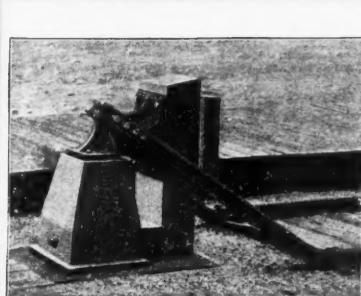
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Railway Supply House, requiring the services of an experienced and efficient salesman, will please communicate with "Supply Man," care this paper.

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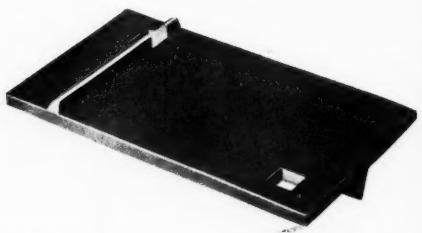
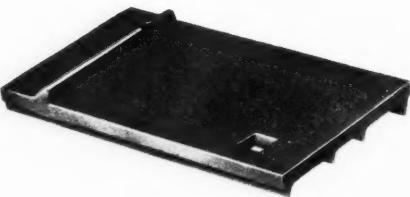
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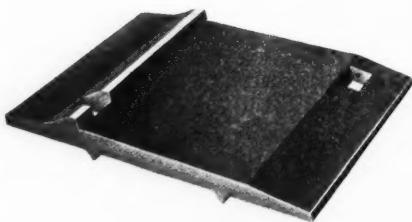


STANDARD SPIKES

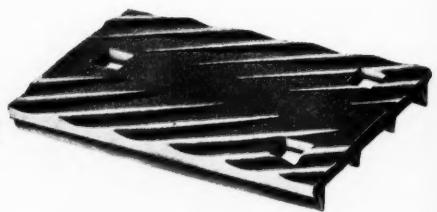


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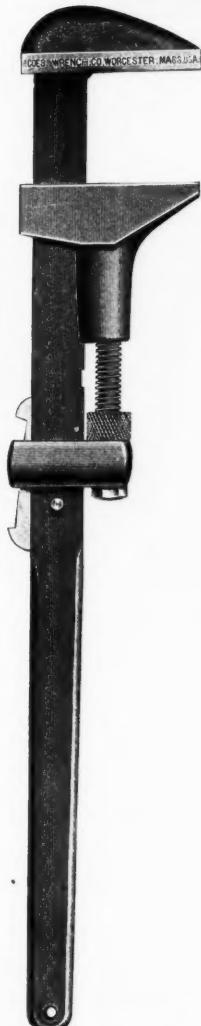


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Railroads



Type Z right hand.

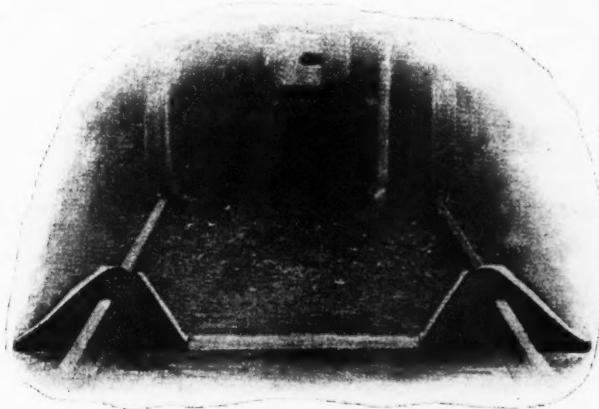
THE JOHNSON FROG:

Straddles the rail—needs no spikes, clamps or fasteners
 Rests on rail both front and rear
 Adjusts itself to different heights of rail
 Forms a friction grip with rail during the operation
 Brings rails to gauge during replacement
 Distributes the load on the rail, not one or two ties.

Range	T. Rail	Capacity	Throat opening	Wgt. each.
Type M for rail 12 - 45 lbs. if not over 3½ inches high	" 20 Ton Locomotive	2 inches	30	
" B " up to 80 "	50 "	3½ "	110	
" A " " 100 "	80 "	3½ "	145	
" Z " " 100 "	100 "	3½ "	165	
" AA " " 105 "	200 " Wreck Outfit	7½ "	275	

Will
 De-Rail
 also

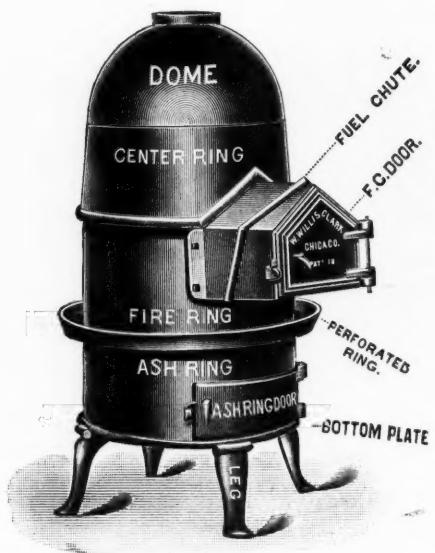
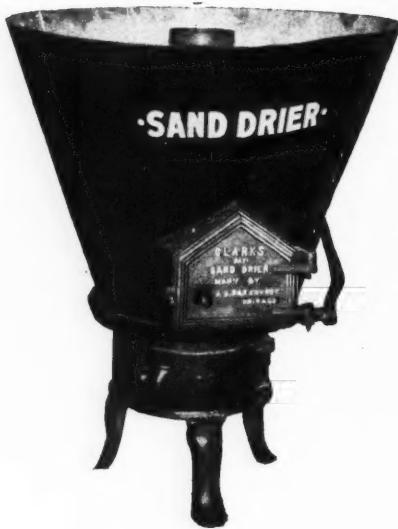
30 Days
 Trial
 Free



After Rerailing 50 Ton Car

THE JOHNSON WRECKING FROG CO.
 CLEVELAND, OHIO

CLARK'S "Perfect" Sand Drier



THE accompanying illustration shows one of the Clark "Perfect" Sand Driers, which are manufactured by J. J. Parkhurst, of Chicago. This sand drier received the premium as the best sand drier at the National Exposition of Railway Appliances, and it is in extensive use not only throughout the United States, but in Canada, Europe and South America. These driers are built in the fashion of an hour glass, the wet sand being shoveled against the stove, and as it dries it runs out through apertures in the perforated ring which surrounds the bottom of the hopper. The amount of sand that will pass through this machine in a given time is variable and depends largely upon the conditions under which it is used, that is to say, how wet the sand is when it is put in the hopper and also the intensity of the fire maintained in the stove. The furnace is arranged to use any kind of solid fuel, such as hard or soft coal or wood. These driers are for use with clear sand only, as earth or clay will merely bake and will not discharge itself from the machine. These driers are claimed to be the best ever put upon the market for preparing sand for use on locomotives and street cars.

SEVERAL THOUSANDS OF THESE DRIERS ARE NOW IN USE.

CAPACITY: No. 1 dries about 10 tons and No. 2 dries 5 tons per day, according to conditions.

We carry extra parts in stock, and can fill orders for repairs without delay.

J. J. PARKHURST, Chicago, Illinois

April, 1910.

FORGINGS OF ALL KINDS

Write us for prices

CLEVELAND CITY FORGE & IRON CO.
CLEVELAND, OHIO

DOUD'S "ACME" CENTER DUMP BUCKET

Indorsed by Some of the Largest Contractors and Most
Eminent Engineers in the Country.

- No slides.
- No springs.
- No complicated parts to get out of order.
- No side jumping.
- No side splashing.
- Deposits load exactly where you want it.

We have never had a bucket returned for any reason

ACME EQUIPMENT & ENGINEERING CO.
6824 UNION AVENUE, CLEVELAND, OHIO

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Write to **THE INDUSTRIAL SUPPLY & EQUIPMENT CO.**

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FAIRBAIRN BUCKETS ARE GOOD DIGGERS

THE
**STRONGEST AND MOST DURABLE
BUCKETS MADE**
**BUILT OF STEEL THROUGHOUT
IN ALL SIZES**

Write for Full Information

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Coal
Sand and Gravel
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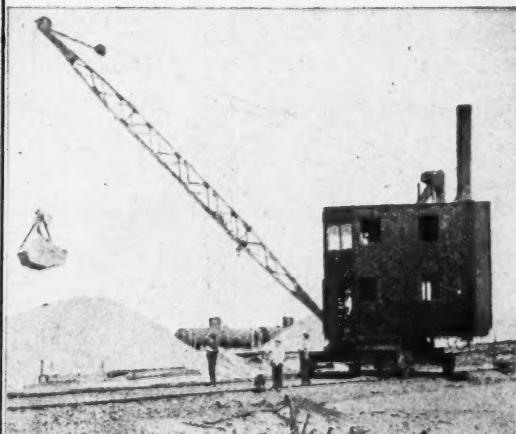
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SPECIAL BUCKETS.



Revolving Derricks

Of the Latest
and Most Approved Types

SPECIAL Excavating Machines

FOR ALL WORK

THE G. H. WILLIAMS COMPANY

CLEVELAND, OHIO

The Groff Drill

ABSOLUTELY SAFE

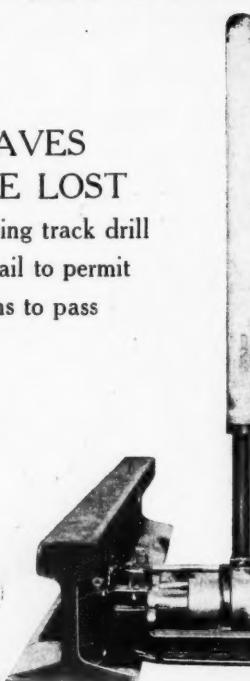
Patented Nov. 27, 1900 Other U. S. and Foreign Patents Pending

The Groff Drill & Machine Tool Co.

SOLE MANUFACTURERS

Camden, N. J., U. S. A.

**SAVES
TIME LOST**
in removing track drill
from rail to permit
trains to pass



**HAS CONTINUOUS MOTION AND
AUTOMATIC FRICTION FEED**

**ADJUSTABLE TO ALL
WEIGHTS OF RAIL**

QUICKLY
and safely attached
to LIVE THIRD
RAIL and allows
SHOE to pass while
machine is in position

**STOP! THE POSSIBILITY OF
TRAIN WRECKS**
By using a track drill that
**PROVIDES PERFECT SAFETY FOR
PASSING TRAINS**

**DRILLS
GIRDER
RAILS,**
takes both rows
of holes by using
gripping gibs of
unequal length.



**DRILLING WITH SPLICE
BARS IN PLACE**

DISTRIBUTORS STANDARD SUPPLY AND EQUIPMENT CO.

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EXCAVATING BUCKET**BEST ON EARTH**Standard Bucket
Type "C" Closed

These
BUCKETS

Standard Bucket
Type "D" Closed

Most Durable Buckets Made. Built Entirely
of Steel

IN ALL SIZES

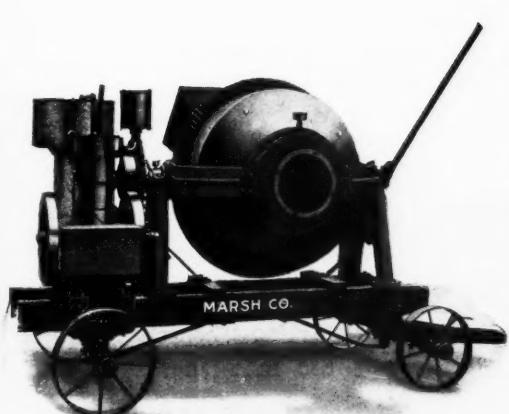
A BUCKET FOR EVERY SERVICE

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THE G. H. WILLIAMS CO.
CLEVELAND, OHIO

Single Rope Bucket
Closed View

FOR
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and
PRICES

Single Rope Bucket
Open View**MARSH MIXERS ARE BEST**

¶ The officers of this company are the same
who sold 3000 mixers.

¶ In doing this we met more than 10,000
buyers.

¶ The experienced advice of these *practical*
men—contractors, engineers and architects—
gave us a world of information on which
to base a new mixer.

That's how we are able

To avoid all the faults.

To keep all the good points and

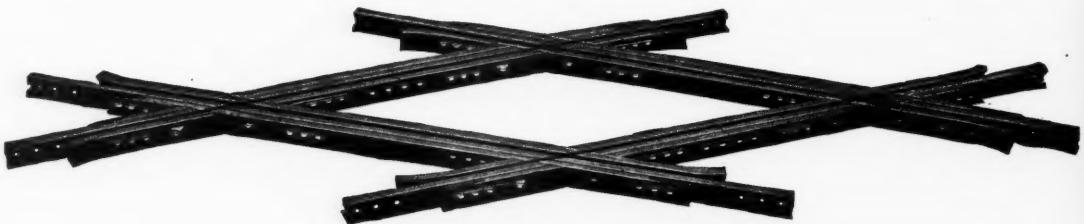
To incorporate new improvements, which *you*, if one
of our former customers, may have suggested.

These are some of the reasons why you should
see us before buying a **Concrete Mixer**

Write for Catalog

MARSH COMPANY, 999 Old Colony Bldg., CHICAGO

Frogs, Switches, Crossings, Stands and Special Track Work High Grade Only



WE OFFER A COMBINATION OF

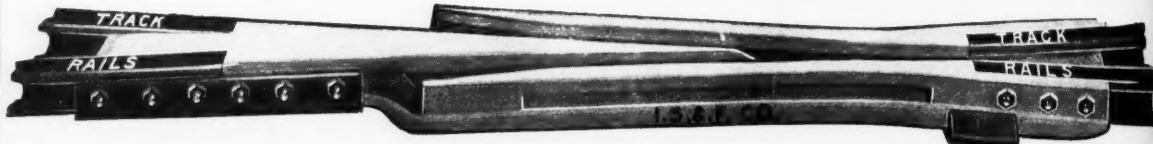
**20 Years of Manufacturing Experience
20 Acres of Manufacturing Facilities**

With the Most Modern Factory of Its Kind in the World

Works at Springfield, Ohio. Absolutely Fire-Proof
(Deliveries NOT Contingent Upon Fire or Flood)

Our product is branded "I. S. & F. Co."---a guarantee that only First Quality and Best of Material is used throughout, and that all rail is drilled (not punched) and no other shop practices tending to reduce cost of manufacture, and detrimental to structure of the steel, are employed. No orders too large for our capacity. No order too small to have attention the day received.

**We Also Make a Specialty of Solid and
Insert Manganese Frogs and Crossings**



The above cut shows our **Model R-N-R Solid Manganese Frog**, which Requires No Renewals of parts during the life of the manganese.

See pages (12) and (13)

The Indianapolis Switch and Frog Company

New York Office, 29 Broadway. J. A. Foulks, Representative.

SPRINGFIELD, OHIO

1910.

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